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Normal Saline Instillation at Neonatal Intensive Care Units: A Descriptive Study of Neonatal Nurses' Knowledge and Practice

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ARTICLE INFO	ABSTRACT
<p><i>Article History:</i> Received: April 24, 2022 Accepted: October 20, 2022</p>	<p>Background: Current evidence no longer supports the instillation of normal saline (NS) during endotracheal suctioning. However, it is unclear whether and to what extent nurses practice NS instillation in Jordan's neonatal intensive-care units (NICUs). Purpose: To describe the knowledge and practice of Jordanian nurses regarding NS instillation before endotracheal suctioning. Methods: A cross-sectional descriptive method was used. Data was collected from 136 NICU nurses using a 29-item self-administered questionnaire. The participants were from 7 NICUs of 7 hospitals in Jordan (north, middle and south of Jordan). The questionnaire asked participants about their knowledge and practice regarding endotracheal suctioning. Results: Findings showed a high frequency of NS instillation during endotracheal suctioning. Among the participants, 44.1% believed that NS was beneficial in loosening secretions, 57.4% believed that it could stimulate the cough response, 56.6% believed that it promoted neonate comfort and 41.2% believed that it could reduce bacterial growth. In practice, 80.0% of nurses used open rather than closed suctioning, 57.1% did not use more than 5 ml of NS during suctioning and 92.4% instilled 0.9% normal saline directly onto the endotracheal tube rather than the in-line suction adapter. Moreover, 53.7% of participants reported that suctioning mechanically ventilated premature neonates out of regularity and not because it was clinically indicated. Conclusion: This is the first study that explored NICU nurses' knowledge and practice of NS use during endotracheal suctioning in Jordan. Educational programs can be implemented to improve knowledge regarding the complications of NS instillation. Implications for Nursing: NICU guidelines should be implemented to ensure that suctioning practices reflect current standards and education and training programs should be developed to target the knowledge and skills of nurses</p> <p>Keywords: Normal saline instillation, Suctioning, Endotracheal tube, NICUs, Jordan.</p>

What does this paper add?

1. This study was the first study conducted with the aim of assessing the gap between knowledge and practice

of neonatal nurses working at Jordanian NICUs.

2. Although evidence-based recommendations regarding adequate methods for NSI are available in

developed countries, many of these recommendations have not been observed among neonatal nurses in Jordan.

3. The nurses' working experience was not significantly related to their knowledge and performance while administering NSI.
4. The results of this study demonstrated that the current practices were not always based upon current-research findings.

Introduction

Endotracheal suctioning is a standard procedure in neonatal intensive-care units (NICUs). Suctioning helps maintain the patency of artificial airways. Among mechanically ventilated neonates, a patent airway is essential to achieve adequate ventilation, reduce peak inspiratory pressure, decrease airway resistance, improve dynamic compliance, increase effective tidal volume delivery, improve oxygen saturation and facilitate gas exchange (Barbosa et al., 2011; Gardner et al., 2009; American Association of Respiratory Care, 2011). The failure to maintain the patency of endotracheal tubes might lead to catastrophic consequences, such as desaturation, atelectasis, cardiac arrhythmias and even death (Sancheti et al., 2015).

One of the practices associated with endotracheal suctioning is the instillation of normal saline (NS) prior to the procedure. The effectiveness of NS instillation before endotracheal suctioning was first investigated almost four decades ago, believing that NS can loosen secretions and enhance cough stimulation. In turn, the decreased viscosity was thought to help mobilize secretions and clear the airway (Özden et al., 2009; Morrow et al., 2004; Owen et al., 2016). However, current evidence shows that NS instillation can have potentially harmful effects, such as cardiac dysrhythmias (Gardner et al., 2009; Celik & Kanan, 2006; AARC Clinical Practice Guidelines, 2010), hypoxemia and desaturation (Gardner et al., 2009; Celik & Kanan, 2006; AARC Clinical Practice Guidelines, 2010; Leddy et al., 2015; Reeve et al., 2007; Akgül et al., 2002), atelectasis (AARC Clinical Practice Guidelines, 2010; Leddy et al., 2015; Ayhan, 2015), bronchospasm (Gardner et al., 2009), worsening dyspnea (Reeve et al., 2007; O'Neal et al., 2001), tachycardia infection (Gardner et al., 2009; Celik & Kanan, 2006; AARC Clinical Practice Guidelines, 2010), trauma to mucosal linings and airway cilia (Gardner et al., 2009), hypertension (Celik & Kanan, 2006; Akgül et al., 2002), increased intracranial

pressure (Gardner et al., 2009; Celik & Kanan, 2006; Akgül et al., 2002) and anxiety and discomfort (Reeve et al., 2007; Ayhan et al., 2015; Blackwood, 1999; Halm et al., 2008; Ireton, 2008).

Despite the adverse consequences associated with NS instillation, some studies documented the persistence of the practice in some NICUs. For instance, a large multicenter trial involving 1665 registered nurses and respiratory physiotherapists from 27 sites in the US (Özden et al., 2009) and a separate trial involving 448 nurses, respiratory therapists and physical therapists in Canada (Blakeman et al., 2022) showed that NS instillation was commonly performed before endotracheal suctioning. More recently, a descriptive exploratory study in Australia found that nurses continued to use NS before endotracheal suctioning based on patients' clinical presentation, clinician judgment and unit practice norms rather than research data (Schults et al., 2018). Moreover, studies found significant variabilities in suctioning practices which might have affected the safety and quality of patient care (Ayhan, 2015; Brooks et al., 1999; Schults et al., 2019).

Although few studies evaluated the instillation of NS in adults, to the authors' knowledge and the literature review (Hussein et al., 2017; Alja'afreh et al., 2018), this is the first study that aims to examine the practice of instilling NS prior to endotracheal suctioning in NICUs in Jordan. To date, no studies have explored the nature and extent of this practice. However, anecdotal data from bedside observations suggest that NICU nurses continue to instil NS before endotracheal suctioning. The lack of research in this area could be an example of the gap in evidence that can have significant implications for ensuring safe suctioning practices. Therefore, this study aims to describe the knowledge and practice of Jordanian NICU nurses regarding NS instillation before endotracheal suctioning.

METHODOLOGY

Design and Settings

The study used a descriptive cross-sectional research design to answer the study question. Seven hospitals participated in the study. The hospitals were selected based on the accessibility and availability of NICU nurses. Recruitment employed a non-probability convenience sampling technique with inclusion-exclusion criteria. Inclusion criteria were: (1)

Completion of a nursing degree (i.e., diploma, bachelor or postgraduate degree) and (2) At least one year of experience working in an NICU. Based on a total accessible population of 160 NICU nurses and aiming for a 5% error rate, 95% confidence interval, a moderate effect size of 0.5 and a power of 0.8, the minimum sample size was 114.

Instrument

The tracheal suctioning questionnaire developed by Schwenker was examined and reviewed by the study team before reaching a consensus. An agreement was reached to use the survey to gather data on the knowledge and practice of nurses on tracheal suctioning. Content validity was established by submitting the questionnaire to a group of NICU specialists made up of two neonatologists, one NICU research nurse and one academic nurse with research experience. Face validity was established after testing five nurses with different levels of education and experience on the English-version survey. The questionnaire in English language was piloted prior to use during data collection. During the pilot test, the study team found the questionnaire easy to use and took only 10 – 15 minutes to complete. The questionnaire was composed of 26 open- and close-ended items that collected data on (1) nurse demographics, (2) care practices for intubated premature neonates, (3) knowledge relating to NS instillation prior to suctioning, (4) practices relating to NS instillation prior to suctioning and (5) factors influencing individual suctioning practices.

Data Collection

The ethics review committee of the sponsoring university and the Ethics of Human Research Committee of the MOH granted ethical approval for data collection.

The data collection period lasted for 7 months. The study team approached the nursing directors of each participating hospital to coordinate data collection. In addition, the study team sent detailed letters explaining the purpose of the study and how data will be collected to the head nurses of each NICU. Head nurses then disseminated information that the study was happening in the hospital sites *via* WhatsApp hospital groups or ward meetings.

NICU nurses who fulfilled the inclusion-exclusion

criteria were invited to participate in the study. Informed consent was sought before enrolling participants. Participants were handed information sheets for them to read prior to consenting. Participants who consented to participate were recruited and given a survey questionnaire to complete. All completed forms were put in a sealed envelope and submitted to the head nurses. Research assistants assigned to each hospital site collected the sealed envelopes from the head nurses and, in turn, handed over the documents to the study team.

Participation was voluntary. No identifying personal information was collected. Each participant was assigned a unique identifier code that matched them to the master list. Only the study team had access to the master list of participants. Responses were confidential and were not disclosed to head nurses.

Data Analysis

The Statistical Package for Social Sciences (SPSS) (IBM Corporation, USA), version 22, was used to analyze data. Percentages and frequencies are presented for total items and each professional respondent group. Means and standard deviations were used to describe the technique of NSI ventilator in relation to the education level.

Results

Demographics

A total of 136 NICU nurses participated in the study. Table 1 shows the demographic characteristics of the participants. Of the nurses, 121 (89%) were females and 15 (11%) were males. Only 4 (3%) participants were practical nurses, while the remaining 132 (97%) were registered nurses. In terms of educational attainment, 3 (2%) nurses completed a diploma degree, 5 (4%) nurses completed an associate degree, 117 (86%) nurses completed an undergraduate degree and 11 (8%) completed a postgraduate master's degree.

When asked regarding their work in NICUs, 11 (8%) nurses reported having a work experience of 8-10 years, 42 (31%) reported 5-8 years, 65 (48%) reported 2-5 years and 7 (5%) reported less than 2 years. In terms of the average daily number of ventilated neonates they encounter while working in NICUs, 118 (89%) nurses experienced taking care of fewer than 4 patients, 9 (7%) experienced taking care of 5-8 patients and 6 (5%) experienced taking care of more than 9 patients.

Table 1. Demographics

	Frequency (n)	Percentage (%)
Age		
< 25 years old	4	3
26-35 years old	91	77
> 36 years old	23	20
Gender		
Male	15	11
Female	121	89
Educational Attainment		
Diploma	3	2
Associate	5	4
Bachelor	117	86
Master	11	8
Professional Title		
Practical nurse	4	3
Registered nurse	132	97
Length as a NICU Nurse		
< 2 years	7	5
2-5 years	65	48
5-8 years	42	31
8-10 years	11	8
> 10 years	11	8
Average Daily Number of Intubated Neonates		
< 4	118	88
5-8	9	7
> 9	6	5

Knowledge Regarding NS Instillation

There were differences in participants' knowledge regarding NS instillation before endotracheal suctioning (Table 2). When asked, 126 (93%) nurses thought that NS instillation could help in the retrieval of more secretions, 78 (57%) thought that it could help cough stimulation response, 78 (57%) thought that it could help

promote neonatal comfort, 56 (41%) thought that it could help reduce bacterial growth and 60 (44%) thought that it could help loosen secretions. On the other hand, 43 (32%) nurses correctly responded that NS instillation could increase the incidence of pulmonary infection and 56 (41%) nurses correctly responded that it could decrease oxygen saturation.

Table 2. Nurses' knowledge regarding NS instillation

	Frequency (n)	Percentage (%)
Perceived benefits of NS instillation		
Retrieval of more secretions	126	93
Stimulation of cough response	78	57
Promotion of neonatal comfort	77	57
Reduction of bacterial growth	56	41
Loosening of secretions	60	44
Correct complications of NS instillation		
Increased risk of pulmonary infection	43	32
Decreased oxygen saturation	56	41

Suctioning Practices

Similar to knowledge, variations were also observed

regarding suctioning practices (Table 3). When asked how frequent nurses assessed breath sounds as an

indicator of the need to suction, 10 (7%) nurses assessed during care, 66 (49%) assessed every 4 hours, 31 (23%) assessed every 3 hours, 19 (14%) assessed every 2 hours and 10 (7%) assessed every one hour. Among the participants, 57 (42%) nurses would usually perform suctioning every 4 hours, 53 (39%) would perform suctioning every 3 hours and 26 (19%) would perform suctioning every 2 hours.

Nurses were asked about the factors that guided their decision on the frequency of suctioning. A total of 61 (45%) nurses identified secretion amount, 36 (27%) nurses identified secretion consistency and 20 (15%) nurses identified neonatal tolerance of suctioning.

All nurses reported performing NS instillation before suctioning, of which 91 (67%) nurses always performed it prior to suctioning, 28 (21%) nurses performed it frequently and 17 (13%) nurses performed it rarely. Despite the practice being termed NS instillation, 10 (8%) nurses reported using sterile water as an irrigant.

Nurses differed in terms of the volume of NS used for instillation prior to each episode of endotracheal suctioning. A total of 76 (57%) nurses used 2-5 ml, 52 (39%) nurses used 5-10 ml and 4 (3%) nurses used 10-20 ml. One nurse reported using up to as much as 20-40 ml of NS prior to endotracheal suctioning.

Table 3. Suctioning practices

	Frequency (n)	Percentage (%)
Frequency of checking breath sounds		
Every 1 hour	10	7
Every 2 hours	19	14
Every 3 hours	31	23
Every 4 hours	66	49
Every care	10	7
Frequency of endotracheal suctioning		
Every 2 hours	26	19
Every 3 hours	53	39
Every 4 hours	57	42
Factors in deciding suctioning frequency		
Secretion amount	61	45
Secretion consistency	36	27
Tolerance of suctioning	20	15
Other	2	2
Frequency of NS instillation		
Never	0	0
Rarely	17	13
Frequently	28	20
Always	91	67
Type of irrigant		
0.9% normal saline	122	92
Sterile water	10	8
Amount of NS for instillation		
2-5 ml	76	57
5-10 ml	52	39
10-20 ml	4	3
20-40 ml	1	1

The used technique of NSI instillation showed that 80.5% of the nurses (n=107) removed the neonate from

the ventilator (open suctioning) when instilling NS. In comparison, 19.5% of the nurses (n=26) used an in-line

adapter (closed suctioning) while instilling NS. Chi-square test revealed significant differences in the irrigant instillation technique favouring the technique that includes removing the neonate from the ventilator (open

suctioning) in relation to nursing education ($p=0.013$). Most baccalaureate-degree nurses tended to instill NS in the ETT after removing the neonate from the ventilator (Table 4).

Table 4. Technique of NSI ventilator in relation to education level

Technique of NSI used by nurses	Items	Nursing education			<i>P-value</i>
		Baccalaureate	Other	Total	
	Removing the neonate from the ventilator	96	11	107	0.013
In-line suction adapter	18	8	26		
Total	114	19	133		

P-values are considered significant at 0.05.

About 66.9% of nurses ($n=90$) indicated performing the first suction pass when disconnecting the neonate from the ventilator during the suctioning procedure. Only 6.9 % of nurses ($n=13$) indicated returning the neonate to the ventilator and performing hyperventilation after the first suction pass during the suctioning process, whereas 28.7 % of the nurses ($n=39$) stated returning the neonate to the ventilator and performing hyperoxygenation after the first suction pass. Only 12 nurses (8.8%) reported applying

hyperinflation when returning the neonate to the ventilator after the first suction. The same percentage of 6.6 % of nurses ($n=9$) indicated that hyperventilation and hyperoxygenation are provided by a bagging device when disconnecting the neonate from the ventilator during suctioning. Also, 5.1 % of the nurses ($n=7$) indicated that hyperinflation was provided to the neonate by a bagging device after the first suction pass while performing the suction to the neonate. At the same time, the neonate was disconnected from the ventilator.

Table 5. Nursing actions performed during the suctioning procedure

Nursing actions performed during suctioning	Answer	Frequency	Percentage	Response rate
Using an in-line adapter	Making first suction pass	106	77.9	100%
	Hyperventilation after suction pass	24	17.6	
	Hyperoxygenation after suction pass	49	36.0	
	Hyperventilation after suction pass	19	14.0	
	Rotating the neonate's head	17	12.5	
	Making second suction pass	5	3.5	
	Making third suction pass	2	1.5	
Disconnecting the patient from the ventilator to perform suctioning	Making first suction pass	91	66.9	97.79%
	Returning neonate to ventilator and Hyperventilation	13	9.6	
	Hyperoxygenation	39	28.7	
	Hyperinflation	12	8.8	

	Bagging infant with bagging device and hyperventilation	9	6.6	
	Hyperoxygenation	9	6.6	
	Hyperinflation	7	5.1	
	Rotating the neonate's head	22	16.2	
	Making second suction pass	9	6.6	
	Making third suction pass	5	3.7	

Discussion

The study was the first attempt to describe the knowledge and practice of Jordanian NICU nurses regarding NS instillation prior to endotracheal suctioning. The results showed that NICU nurses always performed NS instillation, although its frequency differed depending on why nurses felt that NS instillation was essential. Moreover, in terms of knowledge regarding NS instillation, less than a half of the participants correctly identified desaturation and increased pulmonary infection risk as complications of NS instillation. Earlier studies showed some empirical data supporting the value of NS instillation, but current evidence no longer recommends this practice. In a meta-analysis of 5 randomized controlled trials involving 337 patients, patients who did not receive NS instillation had significantly higher oxygen saturation after 5 minutes than those who received NS instillation (Wang et al., 2017). Similar results were found in a multi-method study by Ayhan et al. (2015) and integrative reviews by Schults et al. (2018; 2020). However, the latter suggested that NS instillation might have a positive effect on patients with obstructive mucus.

Suctioning practices varied mainly among the participants, with a mismatch between checking breath sounds as a guide to determine whether suctioning is needed and the frequency of actual endotracheal suctioning. This result might imply that suctioning was done more based on routine than on assessed patient needs. However, this hypothesis will need further validation by observational or time and motion studies. In addition, most of the nurses used secretion amounts to determine whether suctioning was needed. Still, only 20 participants used the tolerance of the procedure to decide on whether the patient will need further suctioning or not. In an integrative review, Goncalves et al. (2015) recommended the need only to perform suctioning only when clinically indicated and to avoid

routinely performing the procedure. The same recommendations were made by Blakeman et al. (2022) for the American Association of Respiratory Care (2010) and Schults et al. (2020).

Limitations of the Study

The study has several limitations. First, the study used a convenience, rather than a randomized, sampling design, thereby limiting the generalizability of the results to hospitals of the same geographical area or with the same characteristics. Second, using a self-report questionnaire might have affected the answers given by participants due to the need for recall, possible time constraints and bias to give favourable responses to questions about knowledge and practice. Third, the study could only assess individual-level factors regarding knowledge and practice about NS instillation before endotracheal suctioning. Future research can explore organizational-level factors that promote or hinder the continued practice of NS instillation in Jordanian NICUs.

Implications for Nursing

The integration of results strongly suggested a departure of suctioning practices, including the continuous use of NS instillation, from current-research data and evidence-based guidelines (Goncalves et al., 2015; Blakeman et al., 2022). This might pose a significant risk to patient safety and the quality of suctioning practices. It is highly recommended to review existing NICU guidelines to ensure that suctioning practices adhere to international benchmarks and are supported by current evidence (Blakeman et al., 2022). In addition, educational and training programs should be implemented to improve knowledge, enhance skills and correct wrongly held beliefs about NS instillation before endotracheal suctioning. In turn, there should be continuous quality improvement efforts, such as audit

checks and regular evaluations, to ensure that actual practice adheres to the implemented changes.

Conclusion

Current evidence no longer supports NS instillation before endotracheal suctioning. This study aimed to explore nurses' knowledge and practice in instilling NS before suctioning intubated neonates in Jordanian NICUs. The results suggested that suctioning practices within NICUs departed from research evidence and other international guidelines, including the continued use of NS before endotracheal suctioning. Changes in such guidelines should be implemented to ensure that

suctioning practices reflect current standards and education and training programs should be developed to target the knowledge and skills of nurses.

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Conflict of Interest

All authors declare that there is no conflict of interests regarding the publication of this paper.

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