









Use of neonatal active humidification: an observational study in high complexity maternity wards

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ABSTRACT

Introduction. Active humidification treatment in incubators effectively reduces risks related to loss of barrier function in preterm infants. However, no conclusive evidence exists on the criteria for active humidification care. This study aimed to describe active humidification in incubators in newborn infants under 32 weeks in high-complexity public maternity hospitals in Argentina.

Methods. An observational and cross-sectional study in supervisors of 68 neonatal intensive care units (NICU) in 2023, using a digital survey, designed *ad hoc*, anonymous, and voluntary, with four dimensions (sociodemographic variables, humidification criteria, nursing care, and humidity decrease, and withdrawal criteria) and 35 questions.

Results. Sixty-four responses were obtained (94%); 84.3% of the NICUs use humidity in the incubators, ranging between 80-90% relative humidity; 57.8% use it, considering the gestational age. The average active humidification time was 11 days. During this period, 84.4% did not perform skin-to-skin contact. The patient's clinical condition was used in 35.9% as a criterion for withdrawal; 30% did not perceive any risk associated with the treatment, and although 48.4% identified a risk of infection, no measures were implemented to reduce it.

Conclusions. The findings of this study show great variability in the criteria for initiation, duration, and withdrawal of active humidification in incubators in newborns younger than 32 weeks.

Keywords: preterm newborn; incubators; neonatal intensive care units; humidifiers.

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INTRODUCTION

Over the last decade, in Argentina, there has been an increase in the prematurity rate of more than 10 percentage points.^{1,2} Newborns (NB) younger than 32 weeks have incomplete development of the epidermal barrier, which makes it inefficient and causes an increase in transepidermal losses (TEL).³⁻⁷

This exposes the neonate to a higher incidence of severe illness,⁸ dehydration,³ hydro-electrolytic instability³ with hypernatremia,⁹ difficulties in thermoregulation,³ and weight loss.^{3,5} TEL varies with relative humidity, temperature, and skin keratinization. The latter characteristic is acquired between 15- and 30 days postnatal life.¹⁰

Active humidification treatment in incubators effectively reduces risks related to loss of barrier function,^{3,7,9,11,12} favors maturation of the *stratum corneum*,^{4,6} decreases TEL and reduces complications, with lower mortality.^{5,13,14} This technique also improves water and electrolyte management,^{6,11,15} increases the growth rate of preterm newborns (PTNB)⁷ -who have a lower incidence of severe disease,⁵ lower weight loss,^{3,5} lower incidence of hypernatremia-^{5,9} and reduces alterations in thermoregulation.^{9,11} However, there is no consensus on some aspects of the implementation of active humidification, such as initiation criteria, duration, humidity percentages, and withdrawal criteria.^{3-5,13}

Regarding starting criteria, the evidence recommends starting humidification at less than 28 weeks or less than 32 weeks gestational age (WGA), although the parameter of the NB weight is also used.³ It is suggested that a humidification percentage of 60% to 85 %^{3,4,6,12,13} and up to 90%⁵ should be used based on the clinical experience of professionals.³ An increased risk of infection is observed with humidification percentages higher than 60%¹³ or 70%.^{3,14}

Data on the length of stay is controversial. Some suggest that the duration should be one week,³ fifteen days,^{3,13} or even extended to one month of life.^{6,12,14} It is also recommended that the percentages and criteria for withdrawal of humidification in incubators be adjusted according to each patient's clinical condition.^{3,6,13,15}

Currently, the available evidence is not conclusive on the criteria and care of active humidification performed in PTNB under 32 weeks of age in Argentina and internationally.^{3,4}

This study contributes to identifying and understanding the variability of this practice at the national level to know the main challenges of this

care.³ This research aims to describe how active humidification is used in incubators in PTNB under 32 WGA in the neonatal intensive care units (NICU) of high-complexity public maternity hospitals in Argentina.

METHODS

Observational, descriptive, and cross-sectional design in nursing supervisors of the NICUs of high complexity public maternity hospitals in Argentina (n = 68) in 2023. Supervisors on leave during the study period were excluded. The entire accessible population was taken. The survey was sent only once. Surveys with negative responses to the following questions were eliminated: a) Do you voluntarily agree to participate in this research study? and b) Do you have incubators with built-in humidity/active humidity in your facility? Participation was voluntary and anonymous; no follow-up was performed, nor was the name of the maternity unit recorded. Approval was obtained from the institutional Ethics Committee (N.º P23-032).

The principal investigator contacted the nursing leaders of the NICUs in September 2023 and presented the research project on the telephone. The instrument used consisted of an *ad hoc* digital survey (Supplementary Material) generated by the research team with four dimensions: sociodemographic variables, humidification criteria, nursing care, and humidity decrease and withdrawal criteria. It contained 35 multiple-choice, dichotomous, or free-response questions about humidification in their units. The survey was conducted in October 2023.

The primary variable was the humidification criteria (start criteria, duration, care, relative humidity percentage, and withdrawal criteria) reported through Google Sheets for analysis. The variables were analyzed using Microsoft Excel®, and the data were analyzed using descriptive statistics through the IBM SPSS v. 23® software package.

RESULTS

Sixty-eight supervisors corresponding to the 68 maternity hospitals classified as 3B by the Ministry of Health were contacted. Sixty-six (97%) agreed to participate in the study. Of these, 2 were eliminated due to the absence of incubators with built-in humidity.

Institutions with active humidification are 58 (90.6%), compared to 6 (9.4%) centers that used both the home method and active humidification.

The main characteristics of the surveyed NICUs show a high patient volume; 30 (45.4%) report more than 2000 deliveries per year, 63 (95.5%) with a high prevalence of NBs <32 WGA requiring humidity during the last three months. Fifty-three (82.8%) had servo-controlled humidity incubators; in 39 (60.9%), skin mode was the most frequent temperature control mode. All the characteristics of the NICUs are described in *Table 1*.

Start of active humidification

The moment of incorporation of humidification was, for the most part, at admission to the NICU in 54 (84.4%), in 9 (14.1%), after cannulation of the umbilical artery and vein, and in 1 (1.6%), in the delivery room.

The indication in 43 (67.2%) NICUs was decided based on a written protocol. In 14 (21.9%) it was a consensual interdisciplinary decision; in 5 (7.8%), it was decided by the neonatologist's criteria, and in 2 (3.1%), by the experience of the nurse in charge.

Regardless of who decided to initiate humidification, 37 (57.8%) NICUs used GA as a parameter, 2 (3.1%) used the newborn's weight, and 25 (39.1%) used both criteria. The results are detailed in *Table 2*.

Nursing supervisors reported that the goals were to decrease insensible water losses (8; 12.5%), maintain body temperature (2; 3.1%),

and decrease electrolyte losses by 2 (3.1%). In 52 NICUs (81.3%), the objectives were all those mentioned in the question, including maturation of the *stratum corneum*.

Nursing care in the implementation of active humidity

Newborns younger than 32 weeks, with active humidification in the incubator, wore diapers in 63 (98.4%) NICUs and, in addition, 38 (59.4%) cotton caps. If an intervention was performed, the newborn was covered with a plastic sheet in 35 (54.7%) NICUs; in 30 (46.9%), they used the incubator porthole sleeves; in 23 (35.9%), they dried the walls of the incubator to prevent the newborn from getting wet due to condensation and to improve its visualization; in 1 (1.6%), they temporarily increased the humidity administered by the incubator; and in 1 (1.6%), they performed other care. In 5 (7.8%), no practice was performed on the preterm newborn before an intervention.

The most frequent perceived risk associated with using active humidity was the risk of infection, 31 (8.4%). The question allowed multiple options to be answered (*Figure 1*).

Regarding the perceived risk of infection, in 46 (71.8%) NICUs used a small sachet, and in 36 (56.2%) sanitized their hands to load distilled water into the incubator humidity system. Before contact with the newborn, in 35 (54.7%) units,

TABLE 1. Characteristics of the maternity wards (n = 64)

Patients attended the maternity wards		AF/RF
Number of births per year	Less than 1000	15 (23.4%)
	Between 1000 and 2000	20 (31.3%)
	More than 2000	28 (43.8%)
	Unknown	1 (1.6%)
Presence of NBs <32 WGA requiring humidity in the last 3 months	Yes	62 (96.9%)
	No	2 (3.1%)
	Unknown	0 (0.0%)
Availability of resources		
Availability of incubators with built-in humidity for all NBs <32 WGA who required it	Yes	53 (82.8%)
	No	11 (17.2%)
Availability of incubators with servo-controlled humidity	Yes	58 (90.6%)
	No	6 (9.4%)
Use of home-made humidification in incubators due to lack of equipment	Yes	6 (9.3%)
	No	58 (90.6%)
Use of open incubators	Yes	43 (67.2%)
	No	21 (32.8%)
Temperature control mode used	Air or manual mode	6 (9.4%)
	Skin or servo-controlled mode	39 (60.9%)
	Both	19 (29.7%)

AF/RF: absolute frequency and relative frequency. NB: newborn. WGA: weeks of gestational age.

professionals wore sterile latex gloves, in 3 (4.7%) used latex-free gloves; in 46 (71.9%), parents performed only hand hygiene before contact with the newborn.

In 54 (84.4 %) NICUs, there was no skin-to-skin contact (STSC) during the entire treatment with incubator humidification (*Table 3*).

Humidity reduction and withdrawal criteria

Fifty-eight (90.6%) NICUs decreased the percentage of moisture progressively, considering different criteria: 23 (35.9%) considered the clinical condition of the NB; 18 (28.1%), the weeks of gestation; 17 (26.6%), the days of postnatal life; and 4 (6.3%), from the first week of treatment.

The indication for definitive withdrawal was based on a written protocol in 33 (51.6%), on a team decision based on the clinical condition of the NB in 24 (37.5%), and in 7 (10.9%) by the neonatologist.

Finally, the patients remained in the same incubator with humidity for an average of 11.08 days (± 7).

DISCUSSION

In most NICUs in Argentina, active humidification is used, with gestational age as the starting criterion. A high percentage of humidity is maintained. Although there is a perceived risk of infection, no measures have been implemented to reduce it.

Previous studies have pointed out the importance and benefits of active humidity, with a direct impact on morbidity and mortality.^{3-5,9,11,12}

However, the lack of incorporation of humidification in some NICUs is of concern.¹² Although using the incubator in air mode is rare, this approach is not advisable at present, but rather to use skin mode.^{12,16-18}

The findings on the criteria for initiating treatment according to GA are consistent with the available evidence. Treatment is initiated in newborns up to 32 WGA.^{3,4,6,9,12,19}

The most significant variability is observed in the initial moisture percentage during the first week of life. The results of this study indicate that a percentage of between 80% and 90%, regardless of GA and weight of the PTBW. However, according to different authors, the literature presents a wider variability, intra- and inter-institutionally, and between countries,³ from 60% to 95% relative humidity during the first week of life.^{4-6,9,12,15,19} In addition, practitioners usually rely on their clinical experience and apply an initial percentage of 90%, although hospital protocols may recommend a lower value.³

To improve the efficacy of the treatment and avoid the decrease of humidity in the cabin,^{12,18,19} it is proposed covering the NB with a plastic sheet,¹⁸ using sleeves on the portholes, placing a plastic sheet, and frequently evaluating the water condensation. Water condensation is especially prevalent in NBs undergoing phototherapy,^{6,12,16,19} and even more if the NB is in phototherapy.^{9,17} In this study, a low use of incubator sleeves was observed.

It is recommended that the NB be kept undressed,^{12,16-18} using a cap and only a diaper.

FIGURE 1. Perceived risks concerning incubator's humidity (n = 64)

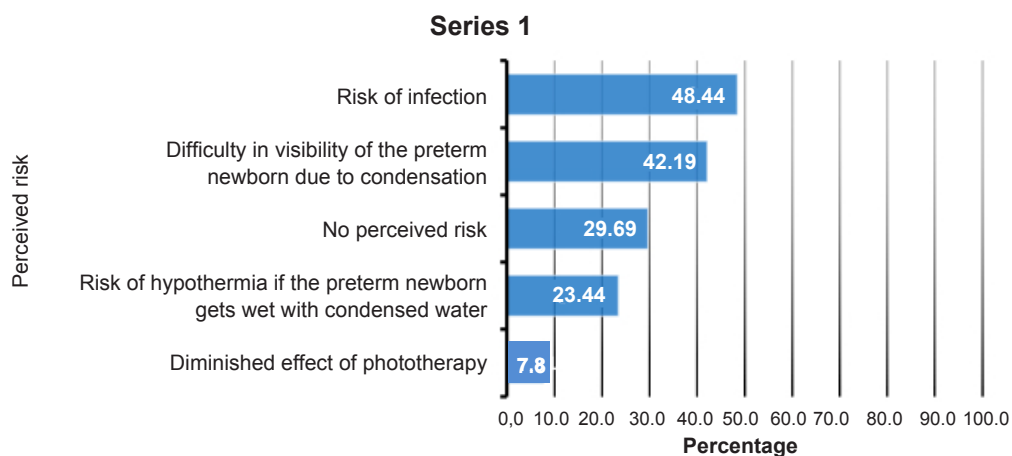


TABLE 2. Distribution of starting criteria and percentage of humidification applied

NICUs using gestational age (GA) or weight criteria, n (%) (n = 39)						
GA or weight categories	Maternity wards' distribution in each category	Percentage of humidification				
		100-90	90-80	80-70	70-60	Other
EG (n = 37)	Total	1 (2.7)	22 (59.5)	11 (29.7)	1 (2.7)	2 (5.4)
31 to <32 WGA	11 (29.7)	0	7	2	0	2
30 to <31 WGA	1 (2.7)	0	0	1	0	0
29 to <30 WGA	10 (27)	1	7	2	0	0
28 to <29 WGA	2 (5.4)	0	1	1	0	0
27 to <28 WGA	6 (16.2)	0	3	2	1	0
26 to <27 WGA	1 (2.7)	0	1	0	0	0
25 to <26 WGA	1 (2.7)	0	0	1	0	0
24 to <25 WGA	0 (0)	0	0	0	0	0
<24 WGA	5 (13.5)	0	3	2	0	0
Other	0 (0)	0	0	0	0	0
Weight (n = 2)	Total	0 (0)	1 (50)	1 (50)	0 (0)	0 (0)
<750 g	0 (0)	0	0	0	0	0
750 g-1000 g	2 (100)	0	1	1	0	0
>1000 g-1500 g	0 (0)	0	0	0	0	0
>1500 g	0 (0)	0	0	0	0	0
Maternities using gestational age (GA) and weight criteria (n = 25)						
Initiation criteria	Maternity wards' initiating by GA and weight	Percentage of humidification				
		100-90	90-80	80-70	70-60	Otro
EG	Total	0 (0)	15 (60)	6 (24)	2 (8)	2 (8)
31 to <32 WGA	2 (8.0)	0	1	0	0	1
30 to <31 WGA	1 (4.0)	0	1	0	0	0
29 to <30 WGA	8 (32)	0	5	1	1	1
28 to <29 WGA	2 (8)	0	2	0	0	0
27 to <28 WGA	6 (24)	0	2	4	0	0
26 to <27 WGA	0 (0)	0	0	0	0	0
25 to <26 WGA	1 (4)	0	1	0	0	0
24 to <25 WGA	1 (4)	0	0	1	0	0
<24 WGA	4 (16)	0	3	0	1	0
Other	0 (0)	0	0	0	0	0
Weight	Total	0 (0)	14 (56)	9 (36)	2 (8)	0 (0)
<750 g	10 (40)	0	7	3	0	0
750 g-1000 g	11 (44)	0	5	4	2	0
>1000 g-1500 g	4 (16)	0	2	2	0	0
>1500 g	0 (0)	0	0	0	0	0

WGA: weeks of gestational age; NICU: Neonatal Intensive Care Unit.

Measurements are expressed in absolute frequency (AF) and relative frequency (RF).

It is unnecessary to increase the body surface area exposed to humidification.^{6,12,16} Low use of plastic sheets and frequent use of the cap were observed.

A crucial aspect is assessing the risk of infection when applying active humidification.^{3,4,12} The permanence of the RN within the same incubator for more than 7 days favors bacterial colonization and proliferation, which significantly increases the risk of infection. Research suggests the possibility of predicting the degree

of contamination based on the temperature and humidity settings in the incubator.^{3,4}

Addressing the risk of infection associated with active humidification is imperative.^{6,14,16}

Currently, hand hygiene is recommended without the need to maintain sterility.^{14,20}

It is suggested that a large, distilled water sachet be used to avoid frequent changes in the filling of the humidifier and to do it with a sterile technique.^{6,9,16} According to experts, a weekly change of the incubator is recommended as long

TABLE 3. Nursing care in patients with incubator humidification (n = 64)

	AF	R
Distilled water load		
Sanitizes hands and cuts water sachet with cutting elements and loads.	36	56.2%
Put on sterile gloves, cut the water sachet with a sterile cutting element, and load.	14	21.9%
Put on sterile gloves, cut the water sachet with a cutting element, and load.	6	9.4%
Other	7	10.9%
Put on mittens and cut the water sachet with a cutting element and load.	1	1.6%
Sachet size		
Sachet of 500 ml	46	71.9%
Sachet of 1000 ml	7	10.9%
Sachet of 2000 ml	9	14.1%
It does not have a closed system.	2	3.1%
Contact elements used by the nursing staff for interventions		
With sterile latex gloves.	35	54.7%
With clean hands: hand hygiene before contact.	11	17.2%
With latex examination gloves.	6	9.4%
With sterile, latex-free gloves.	5	7.8%
Other	4	6.2%
With latex-free gloves.	3	4.7%
Elements of contact used by the family with the newborn		
With clean hands: hand hygiene before contact.	46	71.8%
With sterile latex gloves.	13	20.3%
With sterile, latex-free gloves	3	4.7%
With latex examination gloves.	1	1.6%
With latex-free gloves.	1	1.6%
Other	0	0.0%
Skin-to-skin contact		
No	54	84.4%
Yes	10	15.6%
Phototherapy		
No intervention is required.	43	67.2%
Dry the condensed water on the walls of the incubator.	13	20.3%
Place the light therapy lamp as close as possible to the patient.	7	10.9%
Other	1	1.6%
Frequency of incubator changes		
Every 3 days	1	1.6%
Every 7 days	46	71.8%
Every 10 days	5	7.8%
Every 14 days	3	4.7%
At the end of the treatment	9	14.1%

Answers are from multiple choice.

FA and FR: absolute frequency and relative frequency.

as the treatment is prolonged.⁶

In this sense, the finding of this study is noteworthy, which reveals that, although the risk of infection is perceived, no specific measures are implemented to reduce it. Distilled water is replenished using a non-sterile procedure in a smaller sachet, requiring frequent changes.^{6,12}

In addition, there are differences in hand hygiene practices between parents and healthcare team, who use sterile latex gloves when in contact with NBs. Currently, no evidence is found to

support the use of sterile gloves. Repeated contact of latex with PTNB skin could increase the risk of developing allergies from exposure.^{12,20}

Approximately one-third of the nurse leaders did not identify any associated risks.

A second important care method is STSC, which favors neuroprotection. During humidity treatment, it was not performed in almost all NICUs. Karlsson et al. state that the increase in TEL during STSC is minimal and should not affect fluid balance.²¹ Early, frequent, and prolonged

STSC is indispensable in short- and long-term care.^{21,22}

Finally, regarding the decrease and withdrawal of active humidity, there is unanimous agreement that this should be done progressively and at the neonatologist's indication. The results partially coincide with the study by Erbani,⁵ regarding the gradual decrease in the percentage of relative humidity within a week, coinciding with the 7 to 10 postnatal days required for the stratum corneum to mature. However, the evidence suggests that the decision to withdraw active humidification definitively is based on assessing the PTNB's skin maturity. It may vary according to the individual needs of each NB.^{6,9,12,13} In this regard, Rizk et al.³ warn about the lack of consensus on the criteria for initiation, tapering, and withdrawal of humidification treatment, which could affect morbidity and mortality.

The main limitation of this study was the collection of data through surveys, which recorded the practices of nursing leaders regarding the application of active humidification. However, most services reported seeing these patients regularly, even in the last three months.

CONCLUSION

As a descriptive-exploratory study, a first approach was made to the criteria and care of PTNB with active humidification. In Argentina, this care is performed according to the gestational age of the NB, with high humidity levels. Heterogeneity in the use of associated practices and low adherence to STSC suggest areas for improvement and standardization of care protocols to improve neonatal care. ■

The supplementary material provided with this article is presented as submitted by the authors. It is available at: https://www.sap.org.ar/docs/publicaciones/archivosarg/2025/10482_AO_Chattas_Anexo.pdf

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