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Characterization of neonatal anesthesia in Colombia from a multidisciplinary perspective. Observational study

Caracterización de la anestesia neonatal en Colombia desde una perspectiva multidisciplinaria. Estudio observacional

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What do we know about this problem?

· Newborns have higher postoperative morbidity and mortality compared to the rest of the pediatric population.
· There is a clear relationship between the level of training and experience of the anesthesiologist and neonatal perioperative outcomes.
· Colombia does not have formal specialization programs in pediatric anesthesia.

What does this study contribute?

· This study highlights the differences in the perception of the quality of technical aspects of anesthetic management for surgical neonates in Colombia across different specialties surveyed. It also identifies logistical and staffing challenges in institutions that provide care for surgical neonates, as well as gaps in the curriculum of anesthesiology specialty programs with regards to neonatal anesthesia.

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Abstract

Introduction: The neonatal period, encompassing the first 28 days of life, is marked by low functional reserve and adaptation to extrauterine life. Neonates have higher postoperative morbidity and mortality compared to older pediatric patients. The anesthesiologist's expertise significantly influences neonatal perioperative outcomes. In Colombia, disparities in healthcare access and education impact neonatal anesthesia training. However, there is limited information on neonatal anesthesia practice and training in the country.

Objective: To characterize neonatal anesthesia from the perspective of anesthesiologists, pediatric surgeons, neonatologists, and directors of specialization programs in anesthesiology in Colombia.

Methods: An observational, cross-sectional study was conducted. A survey was administered among practicing anesthesiologists, pediatric surgeons, neonatologists, and directors of anesthesiology programs in Colombia with regards to several aspects of neonatal anesthesia. An ad hoc questionnaire was designed including 5 domains: perception of professional practice, techniques used, technical and logistical resources of the institutions, training received during the anesthesiology residency, and curricular aspects of the anesthesiology postgraduate program in Colombia.

Results: According to the neonatologists, the anesthesia categories with the worst performance were thermoregulation (poorly managed 38.8% and very poorly managed 22.4%) and management of intravenous fluids (poorly managed 34.7% and very poorly managed 6.1%). With regards to the opinion of the pediatric surgeons, the categories with the lowest performance were thermoregulation (poorly managed 12.5%) and the use of vasoactive medications (poorly managed: 6.3% and very poorly managed 3.1%). 77.8% of the country's anesthesiology programs fail to include neonatal anesthesia as part of the syllabus. 61.5% of anesthesiologists considered their training inadequate to manage a surgical neonate and 89.6% believe that pediatric anesthesia should be a subspecialty in Colombia.

Conclusions: There is a discrepancy between anesthesiologists' self-perception of neonatal care and the views of neonatologists and pediatric surgeons. In Colombia, academic training in neonatal anesthesiology appears to be limited, reflecting gaps in the curricular content of training programs.

Keywords: Anesthesia; Neonatal; Colombia; Multidisciplinary; Pediatrics; Anesthesiology.

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Resumen

Introducción: El periodo neonatal, que abarca los primeros 28 días de vida, se caracteriza por una baja reserva funcional y la adaptación a la vida extrauterina. Los neonatos presentan una mayor morbilidad y mortalidad posoperatoria en comparación con los pacientes pediátricos mayores. La experiencia del anestesiólogo influye significativamente en los resultados perioperatorios neonatales. En Colombia, las disparidades en el acceso a la atención médica y la educación afectan la formación en anestesia neonatal. Además, hay información limitada sobre la práctica y la formación en anestesia neonatal en el país.

Objetivo: Caracterizar la anestesia neonatal desde la perspectiva de anestesiólogos, cirujanos pediátricos, neonatólogos y directores de programas de especialización en anestesiología en Colombia.

Métodos: Se realizó un estudio observacional, transversal. Se realizó una encuesta entre anestesiólogos en ejercicio, cirujanos pediátricos, neonatólogos y directores de programas de anestesiología en Colombia con respecto a varios aspectos de la anestesia neonatal. Se diseñó un cuestionario ad hoc que incluía cinco dominios: percepción de la práctica profesional, técnicas utilizadas, recursos técnicos y logísticos de las instituciones, formación recibida durante la residencia en anestesiología y aspectos curriculares del programa de posgrado en anestesiología en Colombia.

Resultados: Según los neonatólogos, las categorías de anestesia con peor desempeño fueron la termorregulación (mal manejada 38,8 % y muy mal manejada 22,4 %) y el manejo de líquidos intravenosos (mal manejado 34,7 % y muy mal manejado 6,1 %). En cuanto a la opinión de los cirujanos pediátricos, las categorías con peor desempeño fueron la termorregulación (mal manejada 12,5 %) y el uso de medicamentos vasoactivos (mal manejado 6,3 % y muy mal manejado 3,1 %). El 77,8 % de los programas de anestesiología del país no incluyen la anestesia neonatal como parte del plan de estudios. El 61,5 % de los anestesiólogos consideraron que su formación era inadecuada para manejar a un neonato quirúrgico y el 89,6 % creen que la anestesia pediátrica debería ser una subespecialidad en Colombia.

Conclusiones: Hay una discrepancia entre la autopercepción de los anestesiólogos sobre el cuidado neonatal y las opiniones de los neonatólogos y cirujanos pediátricos. En Colombia, la formación académica en anestesiología neonatal parece ser limitada, reflejando lagunas en el contenido curricular de los programas de formación.

Palabras clave: Anestesia neonatal; Colombia; Multidisciplinario; Pediatría; Anestesiología.

INTRODUCTION

The neonatal period includes the first 28 days of life. It is characterized by low functional reserve and adaptation to extrauterine life. Several studies have shown that neonates have higher postoperative morbidity and mortality compared to the rest of the pediatric population. (1–3) Therefore, the anesthesiologist caring for the surgical neonate must not only have a thorough understanding of the anatomy, physiology, and pharmacology, as well as the effects of anesthesia on the homeostasis of these patients, but also the skill to assess and define the ranges of physiological normality and intervene promptly and accurately when necessary. (4,5) Consequently, there is a clear relationship between the level of training and experience of the anesthesiologist and the neonatal perioperative outcomes. Another factor that affects perioperative neonatal mortality is the income level of the countries (4,6).

Colombia is a country marked by significant disparities in development and income across its regions. These inequalities have a direct impact on the quality of education and healthcare services. Specifically, access to, and the quality and availability of specialized human and technological resources in high-complexity health institutions, are concentrated in cities with higher per capita income. (6) These differences not only impact the quality of care for the surgical neonate but also the level of training of residents in anesthesiology. In this context, the training of human resources in neonatal anesthesia faces significant challenges. In 2016, the Colombian Society of Anesthesiology and Resuscitation (SCARE) reported that only 20% of anesthesiology specialization programs in Colombia include neonatal anesthesia as part of their curriculum (7). Furthermore, there is no minimum requirement for the number of neonatal cases that must be performed during training. Additionally, Colombia lacks sub-specialization programs in pediatric anesthesia, in contrast to other medical specialties such as surgery and pediatrics, which do offer such specialized training.

There is currently no available information on neonatal anesthesia practices in Colombia, including the quality of academic training, the extent of exposure to surgical neonates during postgraduate education, or the technical and logistical resources available to institutions responsible for their care.

Our goal was to characterize neonatal anesthesia from the perspective of anesthesiologists, pediatric surgeons, neonatologists, and directors of specialization programs in anesthesiology in Colombia.

MATERIALS AND METHODS

Study design

Observational, cross-sectional, survey study. This manuscript was structured

according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

Population and sample

Anesthesiologists, pediatric surgeons, neonatologists, and directors of specialization programs in anesthesiology in Colombia. The sample size was calculated using the Epi Info 7.2 software for a descriptive study taking into account 4 population groups: 3000 anesthesiologists who are active members of SCARE, 300 active ASCON neonatologists, 60 active pediatric surgeons of the Colombian Society of Pediatric Surgery and 23 directors of anesthesiology specialization programs in Colombia with a confidence interval of 95% and a maximum permissible error of 5.5% and an expected proportion of 50%. A sample size of 291 respondents was determined. Given the exploratory nature of the study, we aimed to recruit the highest possible number of participants.

Techniques and instruments

The ad hoc researchers designed four electronic surveys based on a literature review, aimed at different population groups in Colombia: anesthesiologists, pediatric surgeons, neonatologists, and directors of specialization programs in anesthesiology in Colombia. The questionnaires included questions with binary, multiple-choice, and Likert-type responses. Except for an optional open-ended survey question in the anesthesiologists' questionnaire, all questions were mandatory.

The questionnaire for anesthesiologists comprised 53 questions distributed into 5 domains (sociodemographic information, self-perception about their practice during neonatal anesthesia, techniques used in neonatal anesthesia, technical and logistical resources available at the institutions where they practice, as well as the training received during their postgraduate studies in neonatal anesthesia). For pediatric surgeons, 24 questions distributed into 4 domains were asked (sociodemographic information, exposure to neonatal surgery, neonatal care update, and perception of the practice of neonatal anesthesia). The questionnaire for neonatologists comprised 24 questions, divided into 4 domains (sociodemographic information, exposure to the surgical neonate, update on neonatal care, and perception of the practice of neonatal anesthesia). The form addressed to directors of specialization programs in anesthesiology included 13 questions grouped into 2 domains (sociodemographic information and neonatal anesthesia content within their postgraduate academic curriculum). A pilot test was conducted with two participants to evaluate potential issues related to comprehension, ambiguity, or lack of clarity in the survey questions. The forms were distributed via email and WhatsApp to society members and program directors. Each form required the sender's email to prevent duplicate submissions. The questionnaires were available from October 5 to November 10, 2023.

Recruitment

The invitation to participate was extended via the scientific directorates of two national associations (S.C.A.R.E., ASCON) and directly to each of the directors of the anesthesiology specialization programs in Colombia. Graduated medical specialists in active practice within the national territory of these scientific societies and the directors of the academic programs were included. All information was anonymized and protected. The forms were downloaded to a computer where they were tabulated and stored in Excel (Microsoft Windows 10.1, 2023).

Statistical analysis

The data were analyzed with the Stata 16.1 statistical package, evaluating the normal distribution of continuous variables using the Kolmogorov-Smirnov test. Continuous variables without normal distribution were analyzed with the nonparametric Kruskal-Wallis test. Differences in categorical variables were determined using the chi-square test or Fisher's exact test.

Ethical considerations

Approval was obtained from the bioethics committee of the University of Caldas according to Proceedings CBC5-051 of October 2, 2023. Participation in the research was voluntary, and each participant provided informed consent before completing the survey. This study adhered to the ICH E6 guideline on Good Clinical Practice, the principles of the Declaration of Helsinki, and Resolution 8430 of 1993 issued by the Colombian Ministry of Health. It was classified as minimal risk.

RESULTS

Sociodemographic characteristics

A total of 312 completed forms were obtained: 213 from anesthesiologists, 49 from neonatologists, 32 from pediatric surgeons, and 16 from program directors. There were no duplicate forms. All completed forms were included in the statistical analysis. Of the 213 anesthesiologists, 5.6% reported having subspecialization in pediatric anesthesia, 80.3% work in mixed institutions that deliver care to neonates and adults, 61.0% received some type of update in neonatal anesthesia during the past year and 61.5% received formal training in Neonatal cardiopulmonary resuscitation (CPR) in the last 2 years. Additionally, 94.4% of respondents reported having administered neonatal anesthesia at some point in their professional careers, treating an average of 13.8 neonates per year (SD: 23; 95% CI: 10.6). Among pediatric surgeons, 96.4% stated that they held a nationally issued or validated certification. All neonatologists confirmed having had contact with surgical neonates at some point during their careers. Table 1 summarizes the sociodemographic characteristics of the respondents.

Self-perception of anesthesiologists and perception of neonatologists and pediatric surgeons about the performance of the anesthesiologist while delivering care to surgical neonates

23.0% of anesthesiologists considered airway management as the primary challenge or concern for surgical neonates, while 15.0% felt it was the lack of exposure and experience, 13.6% the management of thermoregulation, 10.8% ventilation, 4.7% insufficient training of the operating room support staff, and 3.3% medication dosage. According to the neonatologists, 59.2% of the central catheter insertion procedures are performed by the neonatologist, 30.6% by pediatric surgeons, 10.2% by the neonatal ICU nurse, and never by the anesthesiologist. However, the pediatric surgeons said that at their institution 12.5% catheters were placed by neonatologists, 68.8% by the pediatric surgeon, 15.6% by the neonatal ICU nurse, and 3.1% by anesthesiologists.

Neonatologists identified thermoregulation as the most poorly managed aspect of anesthetic care, with 38.8% rating it as poorly managed and 22.4% as very poorly managed. They also highlighted concerns

Table 1. Demographic characteristics of anesthesiologists, neonatologists, pediatric surgeons, and coordinators of specialization programs in anesthesiology in Colombia.

Question	Answer	Anesthesiologists		Neonatologists		Pediatric surgeons		Program Coordinators	
		n	%	n	%	n	%	n	%
Sex	Female	71	33.3	33	67.3	6	18.8	5	27.8
	Male	142	66.7	16	32.7	26	81.3	13	72.7
Region of Colombia where you work	Andean	142	66.7	32	65.3	20	62.5	14	77.8
	Pacific	43	20.2	12	24.5	7	21.9	2	11.1
	Caribbean	19	8.9	4	8.2	3	9.4	2	11.1
	Orinoquía	9	4.2	0	0.0	2	6.2	0	0
	Amazon	0	0	1	2.0	0	0	0	0
Type of patients receiving care at the different health institutions	Adult and pediatric	171	80.3	NA	NA	NA	NA	NA	NA
	Pediatric and neonatal	27	12.7						
	Non-neonatal pediatric	3	1.4						
	Adults	12	5.6						
Has received an update on surgical neonates in the last 12 months	Yes	83	39	19	38.8	23	71.9	NA	NA
	No	130	61	30	61.2	9	28.1		
Has completed formal training in neonatal CPR over the last 2 years	Yes	82	38.5	48	98.0	13	40.6	NA	NA
	No	131	61.5	1	2.0	19	59.4		
Has administered neonatal anesthesia during their professional practice	Yes	201	94.4	NA	NA	NA	NA	NA	NA
	No	12	5.6	NA	NA	NA	NA		
Years of professional practice	Mean	14.3		12.1		19.2		8.6	
	SD	10.2		9.9		11.5		6.8	
	IC95%	12.7-15.7		9.3-15.0		15.1-23.4		5.2-12.8	
Neonates cared for per year*	Mean	13.8		37.3		22.9		NA	NA
	SD	23.0		41.4		17.0			
	IC95%	10.6-16.9		25.0-49.6		16.6-29.1			
Neonates cared for per month**	Mean	1.2		5.7		2.8		NA	NA
	SD	2.2		7.6		2.2			
	IC95%	0.9-1.5		3.4-7.9		2.0-3.6			

* Neonates receiving general anesthesia each year and who also received care from a neonatologist and pediatric surgeon.
** Neonates receiving general anesthesia each month and who also received care from a neonatologist and pediatric surgeon.
CPR: Cardio-Pulmonary resuscitation; IC95%: 95% confidence interval; NA: Not applicable; SD: Standard deviation.
Source: Authors.

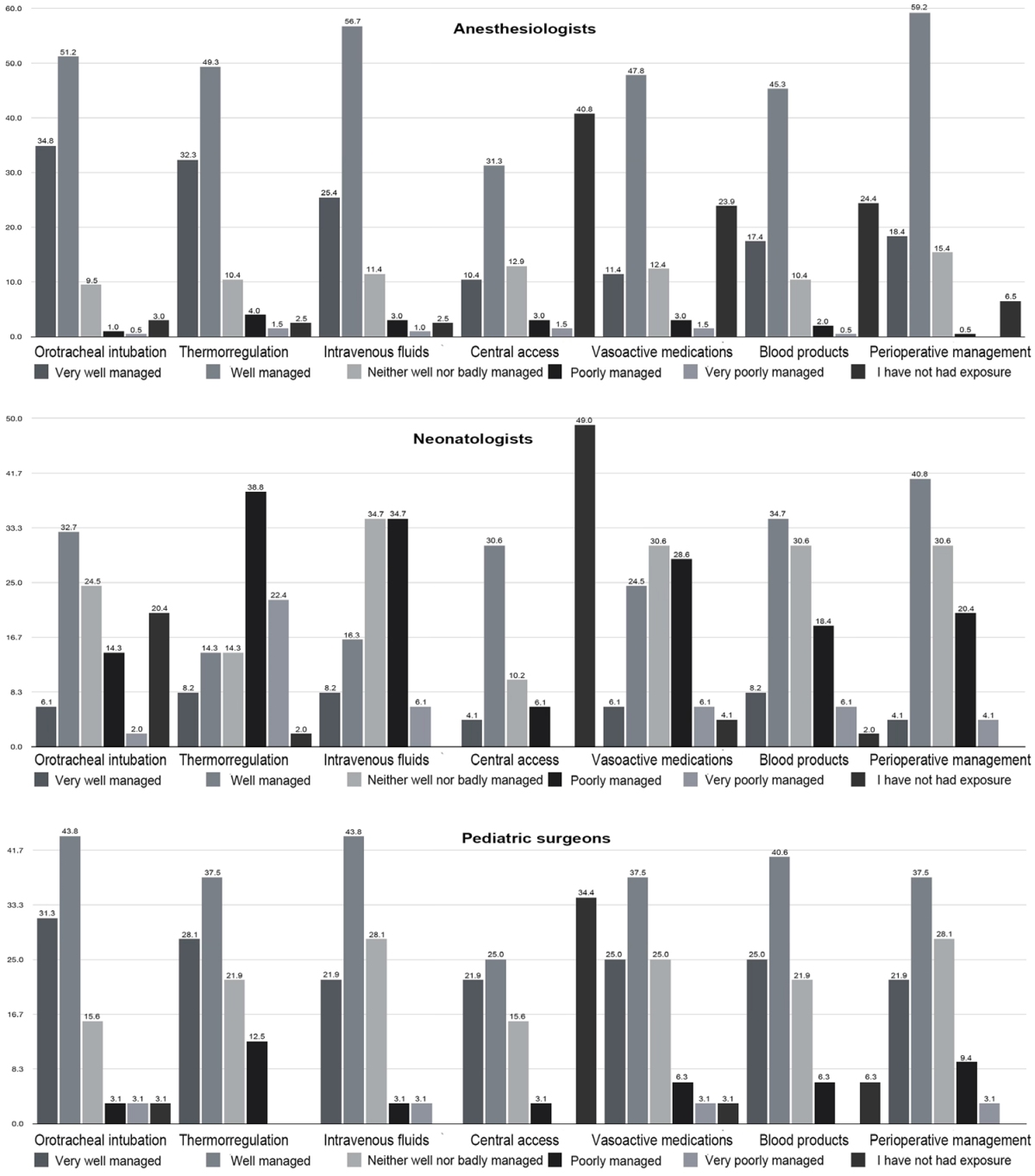
about the management of intravenous fluids, with 34.7% considering it poorly managed and 6.1% very poorly managed. Similarly, pediatric surgeons perceived thermoregulation as the weakest area, with 12.5% rating it as poorly managed, followed by the use of vasoactive medications (poorly managed: 6.3%, very poorly managed: 3.1%).

Table 2 shows the respondents' perceptions of anesthetic practice. Additionally, 89.8% of neonatologists consider it necessary to accompany the anesthesiologist during surgical procedures. Finally, 65.3% of neonatologists and 50% of pediatric surgeons reported having experienced serious complications in their patients due to inadequate anesthesia (Figure 1 and Table 2).

Neonatal anesthesia techniques

Among anesthesiologists, 67.7% stated that they did not require the support of a neonatologist or respiratory therapist

Figure 1. Perception of the practice of neonatal anesthesia by anesthesiologists, neonatologists, and pediatric surgeons in Colombia*.



* The data are expressed in percentages.

Source: Authors.

Table 2. Perception of the practice of neonatal anesthesia by anesthesiologists, neonatologists, and pediatric surgeons in Colombia.

Inquiries about the management of the newborn	Anesthesiologists		Neonatologists		Pediatric surgeons		P
	n	%	n	%	n	%	
Management of orotracheal intubation							
Very well managed	70	34.8	3	6.1	10	31.3	0.000
Well managed	103	51.2	16	32.7	14	43.8	
Neither well nor badly managed	19	9.5	12	24.5	5	15.6	
poorly managed	2	1.0	7	14.3	1	3.1	
Very poorly managed	1	0.5	1	2.0	1	3.1	
I have not had exposure	6	3.0	10	20.4	1	3.1	
Management of thermoregulation							
Very well managed	65	32.3	4	8.2	9	28.1	0.000
Well handled	99	49.3	7	14.3	12	37.5	
Neither well nor badly managed	21	10.4	7	14.3	7	21.9	
poorly managed	8	4.0	19	38.8	4	12.5	
Very poorly managed	3	1.5	11	22.4	0	0.0	
I have not had exposure	5	2.5	1	2.0	0	0.0	
Management of intravenous fluids							
Very well handled	51	25.4	4	8.2	7	21.9	0.000
Well managed	114	56.7	8	16.3	14	43.8	
Neither well nor badly managed	23	11.4	17	34.7	9	28.1	
poorly managed	6	3.0	17	34.7	1	3.1	
Very poorly managed	2	1.0	3	6.1	1	3.1	
I have not had exposure	5	2.5	0	0.0	0	0.0	
Central access management							
Very well managed	21	10.4	2	4.1	7	21.9	0.439
Well managed	63	31.3	15	30.6	8	25.0	
Neither well nor badly managed	26	12.9	5	10.2	5	15.6	
poorly managed	6	3.0	3	6.1	1	3.1	
Very poorly managed	3	1.5	0	0.0	0	0.0	
I have not had exposure	82	40.8	24	49.0	11	34.4	
Management of vasoactive medications							
Very well handled	23	11.4	3	6.1	8	25.0	0.000
Well handled	96	47.8	12	24.5	12	37.5	
Neither well nor badly managed	25	12.4	15	30.6	8	25.0	
poorly managed	6	3.0	14	28.6	2	6.3	
Very poorly managed	3	1.5	3	6.1	1	3.1	
I have not had exposure	48	23.9	2	4.1	1	3.1	
Management of blood products							
Very well managed	35	17.4	4	8.2	8	25.0	0.000
Well managed	91	45.3	17	34.7	13	40.6	
Neither well nor badly managed	21	10.4	15	30.6	7	21.9	
poorly managed	4	2.0	9	18.4	2	6.3	
Very poorly managed	1	0.5	3	6.1	0	0.0	
I have not had exposure	49	24.4	1	2.0	2	6.3	
Perioperative management							
Very well managed	37	18.4	2	4.1	7	21.9	0.000
Well managed	119	59.2	20	40.8	12	37.5	
Neither well nor badly managed	31	15.4	15	30.6	9	28.1	
poorly managed	1	0.5	10	20.4	3	9.4	
Very poorly managed	0	0.0	2	4.1	1	3.1	
I have not had exposure	13	6.5	NA	NA	NA	NA	
Perception of the level of expertise of the anesthesiologist by neonatologists and pediatric surgeons.							
Do you consider it necessary to accompany the anesthesiologist during the procedure?							
Yes	NA	NA	44	89.8	NA	NA	
No	NA	NA	5	10.2	NA	NA	
Do you consider it necessary for the anesthesiologist to have a subspecialty in pediatric anesthesia?							
Yes	NA	NA	48	98.0	30	93.8	
No	NA	NA	1	2.0	2	6.2	

Inquiries about the management of the newborn	Anesthesiologists		Neonatologists		Pediatric surgeons		P
	n	%	n	%	n	%	
Have you had any serious complications (cardiac arrest, death) in a neonate resulting from inadequate anesthesia?							
Yes	NA	NA	32	65.3	16	50.0	
No	NA	NA	17	34.7	16	50.0	
Do you think that pediatric anesthesia should be a subspecialty in Colombia?							
Yes	NA	NA	49	100.0	32	100.0	
No	NA	NA	0	0.0	0	0	

NA: Not applicable.
Source: Authors.

during surgery. Regarding airway management, 10.4% request prior intubation of the neonate before surgery, while 60.2% prefer using a tracheal tube without a cuff. 57.7% prefer intravenous induction, and 74.2% prefer balanced anesthesia for maintenance. 67.7% only use arterial lines in major surgery. 75.1% do not use any risk scores, 63.2% only use atropine in the presence of bradycardia and 16.9% always use it as preoperative premedication. For intravenous fluid management, 35.2% replenished basal needs with dextrose in distilled water supplemented with Natrol and Katrol, while addressing intraoperative losses with lactated Ringer's solution. In contrast, 9% used electrolytes in dextrose with distilled water for both basal needs and intraoperative losses. Table 3 shows the results of the anesthetic techniques used.

When comparing anesthesiologists who managed more than one neonatal case per month, versus who managed less than one neonatal case per month, a significant different was identified in terms of requesting follow-up by a neonatologist or a respiratory therapist (p: 0.05), requesting prior intubation of the patient (p: 0.02), completing update programs in neonatal anesthesia over the past 12 months (p:0.00), and receiving formal training in neonatal CPR over the last 2 years (P:0.00). In contrast, when comparing the same responses between anesthesiologists with and without a subspecialty in pediatric anesthesia, significant differences were found with regards to accompaniment (p:0.05) and updates in neonatal anesthesia and CPR courses (p: 0.01 and 0.04, respectively). The results are shown in Table 4.

Table 3. Techniques during neonatal anesthesia in Colombia.

Question	n	%
Considers the presence of a neonatologist or respiratory therapist essential during the anesthetic procedure		
Yes	65	32.3
No	136	67.7
Request prior intubation of the neonate		
Yes	21	10.4
No	180	89.6
Preference for induction		
Inhalation	85	42.3
Intravenous	116	57.7
During the intraoperative period		
Maintenance with halogenation	26	12.9
Total intravenous anesthesia	26	12.9
Balanced anesthesia	149	74.2
For orotracheal intubation use		
Tube with pneumatic plug	80	39.8
Tube without pneumatic plug	121	60.2
Use of arterial line		
All surgeries	1	0.5
Only in major surgery	136	67.7
Never	64	31.8
Administers routine neonatal risk score		
Yes	15	24.9
No	151	75.1
Use of atropine in neonates		
Always as premedication before induction	3. 4	16.9
Only when there is bradycardia	127	63.2
In special cases	18	9.0
Never	22	10.9
Regarding the use of intravenous fluids		
DDW + natrol + katrol basal and losses	18	9.0
DDw + natrol + katrol basal and SS 0.9% losses	53	26.4
DDw + natrol + katrol basal and SS 0.45% losses	4	2.0
SS 0.9% basal and losses	15	7.5
SS 0.45% basal and losses	2	1.0
DDW + natrol + katrol basal and Ringer losses	71	35.2
Basal Ringer and losses	38	18.9

DDW: dextrose in distilled water; SS: Saline Solution.
Source: Authors.

Table 4. Comparison between anesthesiologists managing more or less than one case per month and anesthesiologists with or without a subspecialty in pediatric anesthesia in Colombia.

	More than one case a month					Subspecialty in pediatric anesthesia				
	0		≥1		p	No		Yes		p
	n	%	n	%		n	%	n	%	
Request support from a neonatologist or respiratory therapist										
Yes	35	39.8	30	26.8	0.05*	64	33.9	1	8.3	0.05*
No	53	60.2	82	73.2		125	66.1	11	91.7	
Request prior intubation										
Yes	14	15.9	7	6.2	0.02*	20	10.6	1	6.2	0.63*
No	74	84.1	105	93.8		129	89.4	11	93.8	
Esophageal atresia mortality rate										
Less than 1%	2	3.6	15	13.9	0.08**	14	9.2	3	25.0	0.07**
1-5%	2	3.6	8	7.4		8	5.2	2	16.7	
6-10%	0	0.0	0	0.0		0	0.0	0	0.0	
>10%	2	3.6	1	0.9		3	2.0	0	0.0	
I don't know the statistics	50	89.2	84	77.8		128	83.6	7	58.3	
Received an update in neonatal anesthesia over the last 12 months										
Yes	17	17.0	66	58.9	0.00*	74	36.8	9	75.0	0.01*
No	83	83.0	46	41.1		127	63.2	3	25.0	
Completed formal training in neonatal CPR over the last 2 years										
Yes	28	28.0	53	47.3	0.00*	74	36.8	8	66.7	0.04*
No	72	72.0	59	52.7		127	63.2	4	33.3	
Describe your training in neonatal anesthesia										
Specific subject	25	28.4	67	59.8	0.00**	33	16.4	2	16.7	0.26*
Topics on pediatric anesthesia	22	25.0	20	17.9		156	74.7	9	75.0	
Topics scattered throughout the syllabus	19	21.6	22	19.6		9	4.4	0	0.0	
Only one seminar or class	22	25.0	3	2.7		1	0.5	1	8.3	
No specific activity	0	0.0	0	0.0		2	1.0	0	0.0	
Describe your training in neonatal intensive care										
Neonatal intensive care rotation	10	10.0	21	18.7	0.02**	30	14.9	1	8.3	0.98*
Rotation in pediatric intensive care including neonatal topics	21	21.0	31	27.7		15	24.9	3	25.0	
Topics scattered throughout the syllabus	23	23.0	17	15.2		38	18.9	2	16.7	
Only one seminar or class	13	13.0	4	3.6		16	8.0	1	8.3	
No specific activity	33	33.0	39	34.8		67	33.3	5	41.7	

*chi-square test. **Fisher's exact test

Source: Authors.

Technical and logistical resources of the institutions where neonatal surgery is performed according to the perception of the anesthesiologists

76.5% of the anesthesiologists surveyed stated that neonatal surgery is performed at the institution where they work. In these institutions, 28.5% of anesthesia machines lack neonatal ventilation modes, 28.5% do not have radiant heat surgical tables, and 43.0% do not have a video laryngoscope with neonatal blades. 47.9% of the institutions fail to adjust the temperature of the operating rooms before the surgical procedure, only 45.5% of cases are performed by the most experienced surgical group and 61.2% of neonatal surgeries are scheduled as the first case of the day. Among those surveyed, 63.6% reported that their institution receives patients who underwent surgery at other facilities, while 4.2% of patients operated on at their institution are later transferred to other hospitals (Table 5).

Table 5. Technical and logistical resources of the institutions where neonatal surgery is performed according to the perception of the anesthesiologists.

Question	n (Yes)	%
Neonatal surgeries are performed at your institution	165	77.5
An anesthesia machine with neonatal ventilation modes is available	118	71.5
A radiant heat surgical table is available	118	71.5
A video laryngoscope with blades for neonates is available	94	57.0
Central catheters for neonates are available	145	87.9
Pediatric intubation guides or stylets are available	131	79.4
Pulse oximetry with a neonatal sensor is available	155	93.9
Neonatal blood pressure monitor is available	156	94.5
A neonatal electro-scalp plate is available	143	86.7
A blood bank is available	152	92.1
The room temperature is adjusted in the OR before neonatal surgery	86	52.1
The most experienced team is scheduled to care for the newborn	75	45.5
If a neonatal surgery is scheduled, it will be the first procedure of the day	101	61.2
Neonates undergo surgery and then are transferred	7	4.2
Patients operated at another institution may be admitted to the neonatal ICU	105	63.6
Esophageal atresia mortality rate		
Less than 1%	17	10.3
1-5%	10	6.1
6-10%	0	0.0
>10%	3	1.8
I don't know the statistics	135	81.8

Source: Authors.

Neonatal anesthesia education and exposure

Among anesthesiologists surveyed, 77.6% stated that their primary source of academic content on neonatal anesthesiology during postgraduate training was integrated into pediatric anesthesia coursework, while 33.8% said they had not been exposed to any specific activity in neonatal intensive care during their training. 61.5% considered their training insufficient to manage a surgical neonate, and 89.6% believe that pediatric anesthesia should be a subspecialty in Colombia. Regarding the number of cases to which they were exposed during the postgraduate course, 64.3% responded that they were involved in more than 10 cases during their training. Table 6 summarizes the results of the academic training and exposure to surgical neonates during training in anesthesiology postgraduate courses.

Neonatal anesthesia education in Colombian anesthesiology postgraduate programs: insights from program directors

When asked about the inclusion of a dedicated neonatal anesthesia course in their postgraduate programs, 77.8% of program directors stated that none existed. Additionally, 83.3% said that the programs do not mandate a minimum number of neonatal anesthesia cases during training, while 33.3% claimed there were no specific activities in neonatal intensive care. Furthermore, 83.3% of respondents believe that pediatric anesthesia should be recognized as a subspecialty in Colombia (1).

DISCUSSION

Colombia faces significant social inequality as evidenced by the unequal distribution of

wealth and low Human Capital and Social Mobility indices, particularly in historically marginalized regions (8). These factors directly impact the quality of healthcare for surgical neonates in the country. The objective of this study was to characterize the care delivered in Colombia to surgical neonates, from a multidisciplinary perspective, exploring the five domains described.

According to this study, most anesthesiologists in Colombia (80.3%) work in mixed hospitals that care for both adult and neonatal patients, while only 12.7% practice exclusively in pediatric facilities. This trend reflects the gradual shutting down of pediatric hospitals in Colombia due to financial unsustainability (6) and the integration of obstetric and neonatal intensive care services. (9) Delivering care to both adult and neonatal patients is challenging both in terms of management and the need for specialized human, technical, and logistical resources. This is evidenced by the logistical difficulties identified in this study, such as temperature regulation in the operating rooms, scheduling, and experience of the surgical team; all of these factors impact the safety, quality, and results of neonatal care.

The impact of constant exposure to the surgical neonate and formal training in pediatric anesthesia in aspects related to airway management (the presence of a neonatologist during surgery or requesting prior intubation) was clearly ascertained in our study. Other studies have emphasized the difference in the rate of complications according to the experience of the anesthesiologist in charge (1,2). This should prompt administrative staff and government entities to establish formal training programs to care for these patients, who not only exhibit the highest perioperative mortality rates but also have significant potential for productive years ahead. (5)

Moreover, the self-perception of anesthesiologists regarding the management of fundamental aspects

Table 6. Academic training and exposure to neonatal anesthesia of anesthesiologists during postgraduate training in anesthesiology in Colombia.

Questions addressed to anesthesiologists	n	%
During training, was neonatal anesthesia part of the syllabus?		
Yes	169	79.3
No	44	20.7
Describe your training in neonatal anesthesia		
Specific subject	35	16.4
Contents on the subject of pediatric anesthesia	165	77.6
Topics scattered throughout the syllabus	9	4.2
Only one seminar or class	2	0.9
No specific activity	2	0.9
Describe your training in neonatal intensive care		
Neonatal intensive care rotation	31	14.6
Pediatric ICU rotation including neonatal topics	53	24.8
Topics scattered throughout the syllabus	40	18.8
Only one seminar or class	17	8.0
No specific activity	72	33.8
Was the training sufficient to manage neonates under general anesthesia		
Yes	82	38.5
No	131	61.5
Number of neonates treated in the postgraduate course		
0	1	0.5
1-5	33	15.5
6-10	42	19.7
>10	137	64.3
Should pediatric anesthesia be a subspecialty in the country		
Yes	190	89.6
No	22	10.4
Neonatal anesthesia content in anesthesiology postgraduate courses in Colombia (Answers submitted by program directors)		
Question	n	%
Did you complete any specific subject or rotation on neonatal anesthesia?		
Yes	4	22.2
No	14	77.8
If the answer is no, was neonatal anesthesia a topic covered as part of another subject?		
Yes	14	77.0
No	0	0.0
Not applicable	4	22.2
Does your postgraduate program mandate a minimum number of neonatal cases during training?		
Yes	3	16.7
No	fifteen	83.3
Which option(s) best describes your residents' training?		
Seminars or topic reviews	17	94.4
Exposure to the surgical neonate in the operating room	16	88.9
Exposure to the surgical neonate in the NICU	8	44.4
Simulation practices	6	33.3
No specific activity	2	11.1
Which option best describes neonatal intensive care training?		
Neonatal intensive care rotation	4	22.2
Rotation in pediatric intensive care with neonatal topics	3	16.7
Topics scattered throughout the syllabus	3	16.7
Only one seminar or class	2	11.1
No specific activity	6	33.3

Questions addressed to anesthesiologists	n	%
Are there any plans to include a rotation or subject on surgical neonates in the future?		
Yes	6	33.3
No	8	44.4
It is already available	4	22.3
Upon completion of your postgraduate program, have any updates been provided?		
Yes	10	55.6
No	8	44.4
Do you think that pediatric anesthesia should be a subspecialty in Colombia?		
Yes	15	83.3
No	3	16.7

Source: Authors.

of the intraoperative period of the neonate and the high incidence of serious complications observed (cardiac arrest and death) differs from the perception of pediatric surgeons and neonatologists. This may be related to the inability to interpret physiological variables in real-time, and hence being unable to successfully intervene in response to the actual needs of the patient. The results of these intraoperative decisions are subsequently observed in the Neonatal Intensive Care Unit (NICU). This is consistent with the reports of multicenter studies such as NECTARINE (2) and APRICOT (10) emphasizing the importance of knowing and interpreting correctly the physiological variables and of standardizing neonatal anesthetic care to reduce the high perioperative risks of these patients. (11)

Regarding neonatal anesthesia techniques, it is notable that 60.2% of anesthesiologists use uncuffed tracheal tubes. Historically, there has been debate over whether cuffed and uncuffed tracheal tubes differ in terms of ease of insertion and the risk of post-extubation stridor. However, studies have shown that cuffed tubes reduce the need for tube exchanges, do not increase the risk of post-extubation stridor, and provide better mechanical ventilation. (12,13) In terms of the use of intravenous fluids in surgery, 73.6 % of anesthesiologists use hypotonic infusions for baseline needs and/or replacement of intraoperative losses, which involves a risk of hyponatremia. To address such risk, the use of isotonic solutions has been recommended to replace intraoperative fluid losses. (14,15) With regards to the use of atropine as premedication prior to the induction of anesthesia, 16.9% of the anesthesiologists said they always used it. In the past, the use of atropine has been recommended to prevent bradycardia during induction and airway manipulation, particularly when administering medications such as succinylcholine, fentanyl, and halothane that potentially induce bradycardia (16,17). There are no arguments for or against the routine use of atropine before neonatal intubation. Due to the known vagal hyperreactivity in neonates, experts believe that it is reasonable to administer atropine preventively, especially if a depolarizing neuromuscular blocker is used or to have atropine ready for the treatment of bradycardia during the procedure (18). In our study, 31.8% of anesthesiologists reported never using invasive blood pressure monitoring. While artificial intelligence-supported non-invasive continuous monitoring systems show promise, forearm cuff-based blood pressure measurement remains imprecise in neonates compared to invasive methods. This discrepancy is particularly evident in cases of hypovolemia and hemodynamic instability. Therefore, invasive blood pressure monitoring should be the preferred method for intraoperative monitoring in most neonatal surgeries. (19)

This research study found that a considerable percentage of institutions that perform neonatal surgeries do not have available basic elements for a safe practice of anesthesia, especially those related to airway management, ventilation, and thermoprotection. 43% do not have a video laryngoscope which is the instrument of choice for orotracheal intubation in neonates (20); 28.5% do not have surgical tables with radiant heat or anesthesia machines with ventilation modes and 20.6% lack tracheal intubation guides. These deficiencies may partly explain why some anesthesiologists request that patients arrive in the operating room already intubated or the need for NICU personnel to be present in the operating room during the procedure. These findings make it mandatory for the healthcare institutions delivering care to this group of patients in the country to make the necessary efforts to improve the basic provision of safe care. Likewise, the high percentage of anesthesiologists unaware of esophageal atresia mortality rates in their institutions—considered a key indicator of neonatal care quality (21,22)—highlights deficiencies in feedback mechanisms and institutional quality processes.

According to the results of this research, the Colombian anesthesiologists considered that the training received during their academic education was insufficient for the care of the surgical neonate. Notwithstanding the consensus recommendation of the Colombian Society of Anesthesiology in 2016 (7), anesthesia programs have not yet incorporated neonatal anesthesia as part of their curricula, and only a few are planning to do so in the future. Therefore, the specific topics on neonatal anesthesia are part of the pediatric anesthesia syllabus or are scattered throughout the curriculum. De Graaff J. et al (23) recently reported important differences among the different countries, both in terms of training and standards of practice of pediatric anesthesia in the European Union and the United Kingdom; this situation mirrors what happens in Latin America, and that is consistent with the results of

this research in Colombia. (21) Although better exposure to surgical neonates by future anesthesiologists is desirable, the concentration of highly complex services delivering care to this population in the large capital cities in the country (6) is an obstacle to achieving this goal in many of the academic programs of the different universities in the country.

Based on these observations, there is consensus among anesthesiologists, neonatologists, pediatric surgeons, and postgraduate directors on the need for the practitioner administering anesthesia to the neonate to have a subspecialty in pediatric anesthesia. However, previous attempts by some universities to implement such programs in the country have failed – notwithstanding the support from the scientific and academic community - due to a lack of political will of the different administrations. (24)

Limitations

The authors acknowledge some of the limitations of this study. The fact that it was a national survey with voluntary participation, the people who agreed to participate may have some special affinity for neonatal anesthesia and represents a selection bias accounting for the large percentage of anesthesiologists administering more than one neonatal anesthesia per month. Moreover, most of the responders are from the Andean region which has the highest per capita income in the country where most of the institutions with the best technological and human resource resources are concentrated. Hence, it is probable that the least developed regions of the country had little impact on the results or maybe there are no institutions available in these areas with the necessary resources for neonatal surgery.

CONCLUSIONS

There is a difference in the self-perception of anesthesiologists and the perception of neonatologists and pediatric surgeons regarding the care provided to the neonate. The training received in neonatal anesthesiology during residency is deficient in Colombia, reflecting poor curricular content in academic programs. Continuous training strategies are required in neonatal anesthesia, as well as strengthening of the institutional culture in the care of neonates, and the creation of formal pediatric anesthesia programs in the country.

ETHICAL DISCLOSURES

Ethics committee approval

Approval was obtained from the bioethics committee of the University of Caldas according to Proceedings CBC5-051 of October 2, 2023.

Protection of human and animal subjects

The authors declare that no experiments were performed on humans or animals for this study. The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics commit-tee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Confidentiality of data

The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent

The authors declare that no patient data appear in this article.

The authors have obtained the written informed consent of the patients or subjects mentioned in the article. The corresponding author is in possession of this document.

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Author's contributions

ATM: Study planning, data collection, interpretation of results and initial and final drafting of the manuscript.
AJ: Conception of the original project, study planning, interpretation of results and initial drafting of the manuscript.
FA: Conception of the original project, study planning, and interpretation of results.

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