sciendo

The Journal of Critical Care Medicine 2024;10(1):19-29

RESEARCH ARTICLE

DOI: 10.2478/jccm-2024-0010

Neonatal Resuscitation Practices in Romania: A Survey of the Romanian Association of Neonatology (ANR) and the Union of European Neonatal and Perinatal Societies (UENPS)

Manuela Cucerea[1], Marta Simon[1*], Silvia Maria Stoicescu[2], Ligia Daniela Blaga[3], Radu Galiș[4], Maria Stamatin[5], Gabriela Olariu[6], Maria Livia Ognean[7]

[1] George Emil Palade University of Medicine, Pharmacy, Science, and Technology of Targu Mures, Romania

[2] Carol Davila University of Medicine and Pharmacy, Bucuresti, Romania

[3] Iuliu Hațieganu University of Medicine and Pharmacy, Cluj-Napoca, Romania

[4] Oradea County Emergency Hospital, Oradea, Romania

[5] Grigore T Popa University of Medicine and Pharmacy, Iasi, Romania

[6] Emergency County Hospital, Timisoara, Romania

[7] Faculty of Medicine, Lucian Blaga University of Sibiu, Sibiu, Romania

Abstract

Introduction: This study is part of a European survey on delivery room practices endorsed by the Union of European Neonatal and Perinatal Societies (UENPS) and the Romanian Association of Neonatology (ANR). The aim of our study was to evaluate the current neonatal resuscitation practices in Romanian maternity hospitals and to compare the results between level III and level II centers.

Material and Methods: The questionnaire was distributed through ANR by email link to heads of neonatal departments of 53 Romanian maternity hospitals with more than one thousand of births per year between October 2019 and September 2020, having 2018 as the reference year for data collection.

Results: The overall response rate to the questionnaire was 62.26% (33/53), 83.33% (15/18) for level-III centers and 51.43% (18/35) for level-II centers. Of the responding centers, 18 (54,54%) were academic hospitals, 15 (83,33%) were level III and 3 (16,67%) level II hospitals. In 2018, responding centers reported 81.139 births representing 42.66% of all Romanian births (190.170). There were significant differences between level-III and level-II maternity hospitals regarding the number of births in 2018 (3028.73±1258.38 vs 1983.78±769.99; P=0.006), lowest GA of routinely assisted infants in delivery room (25.07±3.03 weeks vs 30.44±3.28, P<0.001), inborn infants with BW<1500 admitted to neonatal intensive care unit (NICU) in 2018 (66.86±39.14 g vs 22.87±31.50 g; P=0.002), and antenatal counseling of parents before the delivery of a very preterm infant or an infant with expected problems (60% vs 22.2%; P=0.027). There were no significant differences of thermal and umbilical cord management, positive pressure delivery, heart rate assessment between responding centers.

Conclusion: The adherence to new guidelines was high among responding centers regarding thermal and umbilical cord management, initial FiO2, but aspects like antenatal counseling, EKG monitoring, laryngeal mask, and heated/humidified gases availability and administration, and simulation-based training require further implementation.

Keywords: Romania, delivery room, neonatal resuscitation, survey

Received: 18 October 2023 / Accepted: 8 January 2024

* Correspondence to: Marta Simon, George Emil Palade University of Medicine, Pharmacy, Science, and Technology of Targu Mures, Romania. E-mail: marta.simon@umfst.ro

Introduction

Political changes and socio-economic development in Romania since 1990 together with the implementation of public health measures were associated with important decreasing trends in neonatal mortality from 8.9 deaths per thousand live births in 1990 to 3.1 deaths per thousand live births in 2021 [1,2]. A significant reduction in neonatal mortality can be achieved by immediate assessment and prompt and correct resuscitation of the newborn at birth, especially the high-risk ones. The first minutes after birth ("golden minute") is crucial for establishment of breathing and oxygenation, with major impact on survival and long-term outcome of the newborn [3]. Thus, the implementation of new evidence-based interventions in neonatal resuscitation, such including support of physiologic transition from intrauterine to extrauterine life, umbilical cord management at birth, achievement of neutral thermal environment, titration of the inspiratory fraction of oxygen, the use of non-invasive techniques of respiratory support should be o priority all over the world [4]. The Romanian Association of Neonatology developed and continuously reviewed national guidelines in accordance with the updated American Academy of Pediatrics (AAP)/American Heart Association (AHA) guidelines and International Liaison Committee on Resuscitation (ILCOR) recommendations.

According to the Romanian Standards of Perinatal Care (2002) there are three levels of maternity hospitals classified depending on the level of competence: level I (healthy term infants), level II (healthy and sick full-term and preterm infants over 32 weeks of gestational age who do not require invasive ventilation) and level III (regional centers) where critical infants requiring intensive care and treatment and invasive respiratory support are cared for, especially preterm infants under 32 weeks of gestational age.

The aim of our study was to evaluate the current neonatal resuscitation practices in Romanian maternity hospitals with more than one thousand of births per year and to compare the results between level III and level II centers.

Methods

This study is part of a European survey on delivery room practices endorsed by the Union of European Neonatal and Perinatal Societies (UENPS) and the Romanian Association of Neonatology (ANR). The survey was approved by Padua Provincial Institutional Review Board (protocol # 0035420) and declared as not meeting the criteria for human subject research. The cross-sectional electronic survey was based on a 91-item structured questionnaire elaborated by a committee of experts on neonatal resuscitation and members of the task force of the Neonatal Resuscitation of the Italian Society of Neonatology, having 2018 as the reference year for data collection [5]. The questionnaire was anonymous and contained questions about epidemiological data, perinatal organizational aspects, medical equipment, initial steps interventions, ventilation and oxygen therapy, ethics, and education [5,6,7]. The questionnaire was distributed through ANR by email link (www.surveymonkey.com) to heads of neonatal departments of 53 Romanian maternity hospitals with more than one thousand of births per year between October 2019 and September 2020. The answer to the questionnaire was considered as informed consent of the participants. A reminder was sent to nonresponders for 3 times [5].

Statistical analysis

Statistical analysis was performed using IBM SPSS 23. Means plus standard deviations (SD) were calculated for numerical variables and compared using Independent Samples t-test. Frequencies and proportions (n, %) were used to describe categorical data. Pearson chi-square or Fisher's exact tests were used to compare variables between centers.

Results

The overall response rate to the questionnaire was 62.26% (33/53), 83.33% (15/18) for level-III centers and 51.43% (18/35) for level-II centers. Of the responding centers, 18 (54,54%) were academic hospitals, 15 (83,33%) were level III and 3 (16,67%) level II hospitals. In 2018, responding centers reported 81.139 births representing 42.66% of all Romanian births (190.170) (8). The results of the survey are reported in Tables 1-6.

There were significant differences between level-III and level-II maternity hospitals regarding the number of births in 2018 (3028.73±1258.38 vs 1983.78±769.99; P=0.006), lowest GA of routinely assisted infants in delivery room (25.07±3.03 weeks vs 30.44±3.28, P<0.001), inborn infants with BW<1500 admitted to neonatal intensive care unit (NICU) in 2018 (66.86±39.14 g vs

Table 1. Characteristics of centers and organizational aspects before birth

	Total No (%)	Level III maternity hospital (n=15)	Level II maternity hospital (n=18)	p
Maternity hospital	33	15	18	
Academic hospital	18	15	3	
Number of births 2018	81139	45431 3028.73±1258.38	35708 1983.78±769.99	0.006
Lowest GA of routinely assisted infants in Delivery Room (DR)	33 (100)	25.07±3.03 (23-32) Median 24	30.44±3.28 (23-33) Median 32	<0.001
Inborn infants with BW<1500 admitted to NICU in 2018/No of reporting centres	23 (69.7)	66.86±39.14 14/15 (93.33)	22.87±31.50 15/18 (83.33)	0.002
Outborn infants with BW<1500 admitted to NICU in 2018/No of reporting centres	20 (60.1)	15.50±11.02 14/15 (93.33)	8.93±14.99 15/18 (83.33)	0.193
Antenatal counseling before the delivery	13/33 (39.4)	9/15 (60.0)	4/18 (22.2)	0.027
Available facilities in maternity hospitals				
Nasal CPAP/HFNC	33 (100)	15/15 (100)	18/18 (100)	NA
Mechanical ventilation (MV)	29 (87.9)	15/15 (100)	14/18 (77.8)	0.229
High frequency oscillatory ventilation (HFOV)	20 (60.6)	12/15 (80.0)	8/18 (44.4)	0.041
Inhaled nitric oxide (iNO)	7 (21.2)	7/15 (46.7)	0/18 (0)	0.002
Therapeutic hypothermia	10 (30.3)	8/15 (53.3)	2/18 (11.1)	0.012
CPAP in delivery room	33 (100)	15/15 (100)	18/18 (100)	NA
ECMO	0 (0)	0/15 (0)	0/18 (0)	NA
Resuscitation team present at every delivery	27 (81.8)	12/15 (80)	15/18 (83.3)	0.459
Routinely resuscitation team for a low-risk delivery				
Pediatrician/neonatologist	29 (87.9)	13/15 (86.7)	16/18 (88.9)	0.626
Obstetrician	3 (9.1)	1/15 (6.7)	2/18 (11.1)	0.570
Anesthesiologist	1 (3.0)	0/15 (0)	1/18 (5.6)	0.545
Nurse	6 (18.2)	2/15 (13.3)	4/18 (22.2)	0.423
Midwife	32 (97)	15/15 (100)	17/18 (94.4)	0.545
Routinely resuscitation team for a high-risk delivery				
Pediatrician/neonatologist	33 (100)	15/15 (100)	18/18 (100)	NA
Obstetrician	4 (12.1)	2/15 (13.3)	2/18 (11.1)	0.626
Anesthesiologist	3 (9.1)	1/15 (6.7)	2/18 (11.1)	0.570
Nurse	6 (18.2)	3/15 (20.0)	3/18 (16.7)	0.577
Midwife	33 (100)	15/15 (100)	18/18 (100)	NA
Resuscitation team members qualified with full resuscitation skills				
Pediatrician/neonatologist	33 (100)	15/15 (100)	18/18 (100)	NA
Obstetrician	0 (0)	0/15 (0)	0/18 (0)	NA
Anesthesiologist	8 (24.2)	3/15 (20.0)	5/18 (27.38)	0.459
Nurse	0 (0)	0/15 (0)	0/18 (0)	NA
Gestational age limit for initiating full resuscitation at birth				
Yes	19 (57.6)	15/15 (100.0)	18/18 (100)	NA
Range	20 (60.6)	22-32	22-32	-
Median gestational age	20 (60.6)	24	24	NA
Gestational age limit /No of reporting centres	20 (60.6)	23.53±0.74	24.44±2.04	0.111
Time limit to stop full resuscitation in severely asphyxiated infant				
Yes	24 (72.7)	11/15 (73.3)	13/18 (72.2)	0.627
Time limit (minutes±SD) /No of reporting centers	23 (69.7)	22.73±13.85 / 11/15 (73.3)	20.83±6.33 / 12/18 (66.7)	0.673

22.87±31.50 g; P=0.002), and antenatal counseling of parents before the delivery of a very preterm infant or an infant with expected problems (60% vs 22.2%; P=0.027).

The availability of nasal continuous positive airway pressure (CPAP)/high flow nasal canula (HFNC), mechanical ventilation, CPAP in delivery room, the presence of resuscitation team at every delivery, the routinely presence of pediatrician/neonatologist for a low-risk/high risk delivery, and time limit to stop full resuscitation in severely asphyxiated infant were similar between centers. Level-III maternity hospitals were significantly more able to provide high frequency oscillatory ventilation (HFOV) (80% vs. 44.4%; P=0.041), inhaled nitric oxide (iNO) (46.7% vs. 0%; P=0.002), and therapeutic hypothermia (53.3% vs. 11.1%; P=0.012) as compared to level-II maternity hospitals. (Table 1)

Thermal management for preterm infants (<32 weeks) was similar among centers as regards temperature of delivery/operating room and ensuring thermal comfort to avoid heat loss. Regarding thermal management for infants considered at risk of hypoxic-ischemic encephalopathy (HIE), passive cooling was started between 1-2 hours of life both in level-III and level-II maternity hospitals. (Table 2).

There were no significant differences of umbilical cord management regardless of GA between responding centers. (Tabel 3)

No significant differences were identified between responding level II and III centers regarding available equipment designed for effective ventilation during resuscitation. Air/oxygen blenders, pulse oximeters were available in 87.9% of centers, T-piece devices (Neopuff) in 63.6% and heated/humidified gases in the delivery room in only 51.5% of maternity hospitals (level-III 53.3% vs level-II 50%). For positive pressure delivery, both level III and level II centers preferred T-piece device (Neopuff) followed by self-inflating bag. The PIP levels (cmH_2O) used in term, late preterm, and preterm infants were higher in level-III centers compared with level-II centers, whereas PEEP levels (cmH_2O) used in term and late preterm infants were higher in level-II centers compared with level-III centers, but the difference was not statistically significant. A PEEP level of 5 cmH_2O was preferred for preterm infants both in level-III and level-II centers. Initial FiO_2 was 21% in infants with GA higher than 35 weeks and 30% in preterm infants in all centers. For meconium-stained amniotic fluid management in a non-vigorous infant, starting PPV after removing secretions was the most frequent procedure (66.7%), followed by intubation and subglottic aspiration (15.2%), and suctioning of the oro and nasopharynx before delivery of the shoulders (15.2%), without significant differences between centers. Among technical aspects, fewer level-II resuscitation teams self-evaluated as having excellent skill

Table 2. Temperature and Thermal Management in the Delivery Room

	Total (n=33)	Level III maternity hospitals (n=15)	Level II maternity Hospitals (n=18)	p
Temperature (T°) of DR °C	33 (100)	24.40±1.05	24.39±1.24	0.978
T° of operating room °C	33 (100)	23.33±2.02	23.83±1.82	0.461
Thermal management for preterm infants (<32 weeks)				
Increasing DR T°	13 (39.4)	5/15 (33.3)	8/18 (44.4)	0.386
Preheating the radiant warmer	29 (87.9)	15/15 (100.0)	17/18 (94.4)	0.370
Servo-controlled T°	23 (69.7)	11/15 (73.3)	12/18 (66.7)	0.488
Pre-warmed towels	33 (100)	15/15 (100)	18/18 (100)	NA
Polyethylene plastic bag or wrap	24 (72.7)	11/15 (73.3)	13/18 (72.2)	0.627
Hat	20 (60.6)	10/15 (66.7)	10/18 (55.6)	0.386
Thermal mattress	7 (21.2)	3/15 (20.0)	4/18 (22.2)	0.609
Heated/humidified gases	18 (54.5)	13/15 (86.7)	14/18 (77.8)	0.525
Thermal management for infants considered at risk of HIE - Passive cooling started:				
Within 1 hour				
1-2 hours	19 (57.5)	9/15 (60.0)	10/18 (55.6)	
2-4 hours	2 (6.1)	1/15 (6.7)	1/18 (5.5)	-
4-6 hours	12 (36.4)	5/15 (33.3)	7/18 (38.9)	
Mean±SD	33 (100)	2.53±1.96	2.72±1.93	0.783
Range	33 (100)	1-5	1-5	-
Median	33 (100)	1.0	1.5	-

Table 3. Umbilical Cord Management

	Total (n=33)	Level III maternity hospitals (n=15)	Level II maternity hospitals (n=18)	P
Umbilical cord management in term infants				
Vaginally delivered				
Physiologically based cord clamping (PBCC)	7 (21.2)	4/15 (26.7)	3/18 (16.7)	0.264
Delayed cord clamping (DCC)	23 (69.7)	8/15 (53.3)	10/18 (55.6)	
Immediate cord clamping (ICC)	2 (6.1)	3/15 (20.0)	4/18 (22.2)	
Milking	1 (3.0)	0/15 (0)	1/18 (5.6)	
Elective cesarean-delivered				
PBCC	6 (18.2)	4/15 (26.7)	2/18 (11.1)	0.598
DCC	13 (39.4)	4/15 (26.7)	4/18 (22.2)	
ICC	12 (36.4)	6/15 (40.0)	11/18 (61.1)	
Milking	2 (6.1)	1/15 (6.7)	1/18 (5.6)	
Emergency cesarean-delivered				
PBCC	1 (3.0)	0/15 (0)	1/18 (5.6)	0.216
DCC	2 (6.1)	0/15 (0)	2/18 (11.1)	
ICC	26 (78.8)	13/15 (86.7)	13/18 (72.2)	
Milking	4 (12.1)	2/15 (13.3)	2/18 (11.1)	
Umbilical cord management in preterm infants				
Late preterm				
Vaginally delivered				
PBCC	6 (18.2)	4/15 (26.7)	2/18 (11.1)	0.732
DCC	21 (63.6)	5/15 (33.3)	11/18 (55.6)	
ICC	6 (18.2)	6/15 (40.0)	6/18 (33.3)	
Milking	0 (0)	0/15 (0)	0/18 (0)	
Cesarean-delivered				
PBCC	4 (12.1)	3/15 (20.0)	1/18 (5.5)	0.970
DCC	11 (33.3)	3/15 (20.0)	5/18 (27.8)	
ICC	15 (45.5)	6/15 (40.0)	12/18 (66.7)	
Milking	3 (9.1)	3/15 (20.0)	0/18 (0)	
29-32 weeks preterm				
Vaginally delivered				
PBCC	11 (33.3)	6/14 (42.8)	5/18 (27.8)	0.079
DCC	6 (18.2)	5/14 (35.7)	1/18 (5.5)	
ICC	8 (24.2)	1/14 (7.1)	7/18 (38.9)	
Milking	7 (21.2)	2/14 (14.2)	5/18 (27.8)	
Cesarean-delivered				
PBCC	7 (21.2)	5/15 (33.3)	2/18 (11.1)	0.051
DCC	8 (24.2)	5/15 (33.3)	3/18 (16.7)	
ICC	12 (36.4)	3/15 (20.0)	9/18 (50.0)	
Milking	6 (18.2)	2/15 (13.3)	4/18 (22.2)	
<29 weeks preterm				
Vaginally delivered				
PBCC	8 (24.2)	5/15 (33.3)	3/18 (16.7)	0.164
DCC	7 (21.2)	4/15 (26.7)	3/18 (16.7)	
ICC	12 (36.4)	4/15 (26.7)	8/18 (44.4)	
Milking	6 (18.2)	2/15 (13.3)	4/18 (22.2)	
Cesarean-delivered				
PBCC	7 (21.2)	5/15 (33.3)	2/18 (11.1)	0.160
DCC	7 (21.2)	4/15 (26.7)	3/18 (16.7)	
ICC	13 (39.4)	3/15 (20.0)	10/18 (55.6)	
Milking	6 (18.2)	3/15 (20.0)	3/18 (16.7)	

on performing endotracheal intubation than level-III (Table 4).

All neonatologists are using stethoscopes for heart rate assessment during neonatal resuscitation, 63.6% of

Table 4. Airway and ventilation in the delivery room

	Total	Level III maternity hospitals (n=15)	Level II maternity Hospital (n=18)	P
Available facilities in hospitals				
Air/oxygen blender	29 (87.9)	15/15 (100)	14/18 (77.8)	0.075
Pulse oximeter	29 (87.9)	15/15 (100)	14/18 (77.8)	0.075
Heated/humidified gases availability	17 (51.5)	8/15 (53.3)	9/18 (50.0)	0.483
Initial FiO2				
≥35-week				
21%	27 (81.8)	12/15 (80.0)	15/18 (83.3)	-
30%	5 (15.2)	3/15 (20.0)	2/18(11.1)	-
50%	1 (3.0)	0/15 (0)	1 (5.5)	-
Mean±SD	33 (100)	22.80±3.72	23.61±7.19	0.696
Range	33 (100)	21-30	21-100	-
Median	33 (100)	21	21	-
<35-week infant				
21%	5 (15.2)	1/15 (6.7)	4/18 (22.2)	-
25-30%	24 (70.7)	14/15 (93.3)	10/18 (55.5)	-
40%	2 (6.1)	0/15 (0)	2/18 (11.1)	-
60%	1 (3.0)	0/15 (0)	1/18 (5.5)	-
100%	1 (3.0)	0/15 (0)	1/18 (5.5)	-
Mean±SD	33 (100)	29.40±2.32	34.31±18.79	0.316
Range	33 (100)	21-30	21-100	-
Median	33 (100)	30	30	-
PPV				
Self-inflating bag	12 (36.4)	7/15 (46.7)	5/18 (27.8)	0.514
T-piece device (Neopuff)	21 (63.6)	10/15 (66.7)	11/18 (61.1)	
Mechanical ventilator	0 (0)			
Ventilatory interface routinely used				
Facial mask	24 (72.7)	14/15 (93.3)	10/18 (55.5)	0.018
Short binasal prongs	9 (27.3)	1/15 (6.7)	8/18 (44.4)	
Laryngeal mask	4 (12.1)	2/15 (13.3)	2/18 (11.1)	0.626
The skill of the team on intubation				
Excellent	16 (48.5)	10/15 (66.7)	6/18 (33.3)	0.141
Good	13 (39.4)	5/15 (33.3)	8/18 (44.4)	
Sufficient	3 (9.11)	0/15 (0)	3/18 (16.7)	
Insufficient	3 (3.0)	0/15 (0)	1/18 (5.5)	
Sustained lung inflation				
Yes, routinely	7 (24.2)	2/15 (13.3)	5/18 (27.8)	0.140
Yes, occasionally	8 (21.2)	6/15 (40.0)	2/18 (11.1)	
Never	18 (54.5)	7/15 (46.7)	11/18 (61.1)	
PIP levels routinely administered to start PPV (cmH2O)				
Late preterm and term infants				
<18 cm H2O	7 (21.2)	2/15 (13.3)	5/18 (27.8)	0.225
20 cm H2O	9 (27.3)	4/15 (26.7)	5/18 (27.8)	
25 cm H2O	17 (51.5)	9/15 (60.0)	8/18 (44.4)	
Mean±SD	33 (100)	22.0±3.23	20.72±2.69	
Range	33 (100)	15-25	16-25	
Median	33 (100)	21	20	

(Continued on page 25)

	Total	Level III maternity hospitals (n=15)	Level II maternity Hospital (n=18)	P
Preterm infants				
<18 cm H2O	14 (42.4)	4/12 (33.3)	10/17 (58.8)	-
20 cm H2O	11 (33.3)	3/12 (25.0)	1/17 (5.9)	-
25 cm H2O	4 (12.1)	5/12 (41.7)	6/17 (35.3)	-
Mean±SD	33 (100)	20.42±3.39	18.76±3.68	0.230
Range	33 (100)	15-25	8-25	-
Median	33 (100)	20	18	-
PEEP levels (cmH2O)				
Late preterm and term infants				
4	1 (3.0)	0/15 (0)	1/18 (5.5)	-
5	16 (48.5)	9/15 (60.0)	7/18 (38.9)	-
6	14 (42.4)	5/15 (33.3)	9/18 (50.0)	-
7	1 (3.0)	1/15 (6.7)	1/18 (5.5)	-
8	1 (3.0)	0/15 (0)	0/18 (0)	-
Mean±SD	33 (100)	5.47±0.64	5.61±0.85	0.592
Range	33 (100)	5-7	4-8	-
Median	33 (100)	5	6	-
Preterm infants				
5	18 (54.5)	8/12 (66.7)	10/17 (58.8)	-
6	10 (30.3)	3/12 (25.0)	7/17 (41.2)	-
7	1 (3.0)	1/12 (8.3)	0/17 (0)	-
8	0 (0)	0/12	0/17	-
Mean±SD	33 (100)	5.42±0.67	5.41±0.50	0.982
Range	33 (100)	5-7	5-6	-
Median	33 (100)	5	5	-
Meconium-stained amniotic fluid management in a non-vigorous infant				
Suctioning of the oro- and nasopharynx before delivery of the shoulders	5 (15.2)	2/14 (14.3)	3/18 (16.7)	0.467
Intubation and subglottic aspiration	5 (15.2)	1/14 (7.1)	4/18 (22.2)	
Starting PPV after removing secretions	22 (66.7)	11/14 (78.6)	11/18 (61.1)	

them are also using palpation of the umbilical cord, but only 6.1% are using a three-lead ECG monitor, without differences between centers. Surfactant and caffeine administration in delivery room was similar among centers. Sodium bicarbonate was still used in delivery room only in level-II maternities although in a small proportion (16.7%) (Table 5).

Courses and training on neonatal resuscitation are routinely held in all Romanian maternity hospitals, in 60.1% of units at 6-12 months, and in 39.45% at 12-24 months. Most of these courses follow neonatal resuscitation algorithm of American Academy of Pediatrics (AAP) (84.8%) (Table 6).

Discussion

The Romanian survey evaluated the neonatal resuscitation practices in maternity hospitals with more than 1000 of births per year. Overall, all regions of the country were represented in the study and the results are reflecting an important part of the neonatal level II and III centers in Romania (42.66% of the number of births in 2018). The results demonstrated no major variations in the delivery room management of term and preterm infants between the centers, highlighting a good compliance with international/national guidelines.

Before birth and ethics

Antenatal counseling of parents before the delivery of a very preterm infant or an infant with expected problems or complications was routinely performed in 39.4% of maternity hospitals, significantly more often in level-III centers who are competent and equipped for caring for the most critical patients. This rate is still lower than the overall rate of European (77%) [5], Ital-

Table 5. Circulation, and Medications in the delivery room

	Total (n=33)	Level III maternity (n=15)	Level II maternity (n=18)	P
Heart rate assessment				
Palpation of the umbilical cord	21 (63.6)	8/15 (53.3)	13/18 (72.2)	**0.224**
Palpation of peripheral pulses	1 (3.0)	0/15 (0)	1/18 (5.5)	**0.545**
Stethoscope	33 (100)	15/15 (100)	18/18 (100)	**NA**
Three-lead ECG monitor	2 (6.1)	0/15 (0)	2/18 (11.1)	**0.290**
Pulse oximeter	22 (66.7)	11/15 (73.3)	11/18 (61.1)	**0.357**
Surfactant use in delivery room				
Yes	12 (36.4)	7/15 (46.7)	5/18 (27.8)	**0.224**
LISA	2 (6.1)	1/14 (7.1)	1/18 (5.5)	**0.692**
INSURE	9 (27.3)	6/15 (40.0)	3/18 (16.7)	**0.135**
Caffeine use in delivery room				
Yes	4 (12.1)	2/15 (13.3)	2/18 (11.1)	**0.626**
Sodium bicarbonate use in delivery room				
Yes	3 (9.1)	0/15 (0)	3/18 (16.7)	**0.150**
Asphyxia	1 (3.0)	0/15 (0)	1/18 (5.5)	**0.253**
Severe metabolic acidosis	2 (6.1)	0/15 (0)	2/18 (11.1)	

Table 6. Education

	Total (n=33)	Level III maternity hospitals (n=15)	Level II maternity Hospitals (n=18)	P
Courses on neonatal resuscitation routinely				
6-12 months	20 (60.1)	11/15 (73.3)	9/18 (50.0)	
12-24 months	13 (39.4)	4/15 (26.7)	9/18 (50.0)	0.157
>24 months	0 (0)	0/15 (0)	0/18 (0)	
Neonatal Resuscitation algorithm				
American Academy of Pediatrics (AAP)	28 (84.8)	11/15 (73.3)	17/18 n (94.4)	
European Resuscitation Council (ERC)	3 (9.1)	2/15 (13.3)	1/18 (5.5)	0.185
Romanian Resuscitation Guidelines	3 (9.1)	2/15 (13.3)	1/18 (5.5)	

ian (90%) [7] and Turkish hospitals (56%) [6]. Antenatal counselling done together by the neonatologist and obstetrician is recommended internationally [9,10]. The counseling should provide objective and realistic information about the risks of morbidity and mortality in extremely preterm infants. The decision on early intensive care (resuscitation and neonatal intensive care) versus palliative comfort care (providing warmth and comfort without medical assistance) should be a shared decision between parents and professionals after counseling. Involving parents in decision making is recommended for the infant's best interest [11].

The median gestational age for initiating full resuscitation at birth was 24 weeks in our study, the legal age of viability in Romania. The limit of viability has been set at 22-23 weeks (Japan, Germany, Sweden), 23-24 weeks (United Kingdom, USA, Canada), 24-26 weeks (France, Netherlands, Switzerland) [12].

In the Romanian study, the time limit to stop full resuscitation in severely asphyxiated infant was 22.73±13.85 minutes in level-III and 20.83±6.33 minutes in level-II maternity hospitals. According to international guidelines, the individualized decision to continue or discontinue resuscitation should be considered at about 20 minutes after birth if the heart rate remains undetectable and all steps of resuscitation have been completed [13,14].

The presence of a resuscitation team at all high-risk deliveries was similar in Romanian centers. A neonatologist or pediatrician qualified with full resuscitation skills attended 87.9% of low-risk deliveries and 100% of high-risk deliveries, in accordance with resuscitation international guidelines [13,14].

Temperature and Thermal Management in the Delivery Room

Thermal instability after delivery is a risk factor for increasing morbidity and mortality in infants. Therefore, the maintenance of the infant's temperature between 36.5°C and 37.5°C is crucial during resuscitation and

stabilization at birth. This implies adequate maintenance of ambient temperature at minimum 24°C, use of preheated resuscitation table and towels, servo-controlled temperature, hats, polyethylene plastic bag for preterm infants and heated/humidified medical gases [13,14,15]. According to Romanian survey, the neonatologists are very concerned about preventing heat loss of the in the delivery room. Use of pre-warmed towels (100%), preheating the radiant warmer/resuscitation table (87.9%), polyethylene plastic bag (72.7%) were the most frequent measures instituted among maternity hospital regardless of level of competence. Instead, heated/humidified gases were used in only 54.5% of centers. As the effects of hypothermia are known for infants considered at risk for hypoxic-ischemic encephalopathy (HIE) [16], passive cooling was started in all maternities within the first 6 hours after birth, with more than 50% of units instituting this preventive measure within the first two hours of life.

Umbilical Cord Management

The timing of cord clamping continues to vary in practice according to local clinical policy. Based on available scientific evidence delayed cord clamping (DCC) - after at least 30–60 seconds after birth - has been shown beneficial in preventing anemia and iron deficiency in full-term infants and in reducing need for blood transfusion and decreasing complications, including intraventricular hemorrhage and necrotizing enterocolitis in preterm infants, thus improving outcomes [13,17]. Physiological based cord clamping (PBCC) - sectioning the umbilical cord after lung aeration or initiating respiratory support - is at least as effective as stabilization through DCC [18,19,20]. Immediate cord clamping (ICC) should be considered for cases of maternal hemorrhage, placental abruption, placenta previa. Cord milking may be an alternative to DCC but should be avoided in very preterm infants because complications like brain injury [13].

Our findings show that DCC was provided to more than 60% of vaginally delivered healthy term and late preterm infants in both level-III and level-II centers, similar to reports in other studies [5,6,7]. In term and late preterm infants delivered by elective caesarean section, DCC decreased to less than 40% and in emergency cesarean to less than 7%. In vaginally delivered preterm infants with gestational age between 29-32 weeks, PBCC was preferred, while in caesarean births ~~it~~ prevailed ICC. In newborns with a gestational age of less than 29 weeks, ICC was preferred both for those born vaginally and by caesarean section.

Airway and ventilation in the delivery room

Effective ventilation is the most important intervention for successful neonatal transition and resuscitation. Hence, the priority is to initiate positive pressure ventilation in the "golden minute" after assessment of need for resuscitation, initial steps, assessment of heart rate/breathing, if the infant is apneic or has a heart rate below 100/min [21]. The Romanian study showed that in both level-III and level-II maternity hospitals there is a high confidence in routinely use of T-piece device (Neopuff) and face mask to administer positive pressure ventilation. It seems that this is a general trend described in other studies as well (5,6,7). Although laryngeal mask is recommended by the International Guidelines [4,14,22] as part of the resuscitation equipment, less than 13% of responders use it when intubation fails. An air-oxygen blender and a pulse oximeter for oxygen titration guiding are available in almost all interviewed Romanian maternity hospitals.

Circulation, and Medications in the delivery room

A rise in heart rate is the most important indicator of favorable response to resuscitative interventions and effective ventilation is the most important step to correct heart rate below 100/min [21,22]. In both level-III and level-II maternity hospitals the stethoscope is the first choice for evaluating heart rate during resuscitation, while the use of ECG monitor - as the International Guidelines are recommending - had low adherence, probably due to lack of equipment. Sodium bicarbonate is still used in delivery room, only level-II centers, apparently only in documented situations.

Education

Neonatal resuscitation teams must continuously train and adapt to the latest evidence-based resuscitation guidelines. The skills and behaviors needed to perform effectively are acquired through continuous and simulation-based training. All maternity hospitals reported that retraining is done more frequently than every 2 years, which is optimal. Romanian Neonatology Association developed a national guideline for neonatal resuscitation in accordance with international guidelines and play an important role in organizing courses, workshops, summer-schools on this topic. The neona-

tal resuscitation program (NRP) is a part of training healthcare professionals carrying for newborns.

Strengths and limitations of the study

The representativity of the sample was satisfactory, given that responding centers reported on 42.66% of all Romanian births in 2018. The overall response rate to the questionnaire was 62.26%, higher in level-III (83.33%) and limited in level-II (51.43%). Maternity hospitals that report less than a thousand births per year were not considered because the European questionnaire was designed only for hospitals with more than a thousand births per year. For a more accurate picture of the resuscitation practices in Romania, we should also include in the study the level-I maternities hospitals that do not have neonatal intensive care (NICU) in their structure.

Conclusions

The results of the Romanian survey are reflecting the implementation stage of international and national guidelines of neonatal resuscitation in maternity hospitals with more than 1000 births per year. The adherence to new guidelines was high among responding centers regarding thermal and umbilical cord management, initial FiO_2, but aspects like antenatal counseling, EKG monitoring, laryngeal mask, and heated/humidified gases availability and administration, and simulation-based training require further implementation.

Acknowledgements

We thank all contact persons who helped run the survey: Mihaela Demetrian, Amalia Stănescu, Roșca Ioana, Cristina Elena Chiriac, Pătrașcu Georgeta (Bucuresti), Filimon Angelica Teodora (Arad), Olimpia Petrescu (Brașov), Husac Camelia (Bacău), Mihaela Gheonea, Mirela Anișoara Siminel (Craiova), Hodiș Dana (Baia-Mare), Tanca Aurelia (Bistrița), Bobe Mădălin (Buzău), Stefan Carmen (Călărași), Andrei Anca (Focșani), Maria Cristina Sandu (Galați), Murariu Georgeta Laura Dana (Suceava), Toth Basa Boglarka (Satu-Mare), Gabriella Gyulai (Sfântu-Gheorghe), Melinte Andreea (Rădăuți), Laura Mihaela Suciu (Tîrgu Mureș), Aldea Roxana (Târgoviște), Melinda Baizat (Zalău), Galita Marius-Daniel (Vaslui)

Conflict of interest

None to declare.

References

1. Bank TW. Mortality rate, neonatal (per 1,000 live births), 2021. Available: https://data.worldbank.org/indicator/SH.DYN.NMRT?end=2021&locations=RO&start=1989&view=chart
2. https://ec.europa.eu/eurostat/databrowser/view/demo_minfind/default/table?lang=en
3. Girish M, Subramaniam G. The golden minute after birth – beyond resuscitation. Int J Adv Med Health Res 2019;6:41-5.
4. Wyckoff MH, Wyllie J, Aziz K, et al. Neonatal Life Support Collaborators. Neonatal Life Support: 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation. 2020;142:S185–S221.
5. Trevisanuto D, Gizzi C, Gagliardi L, et al. Union of European Neonatal and Perinatal Societies (UENPS) Study Committee. Neonatal Resuscitation Practices in Europe: A Survey of the Union of European Neonatal and Perinatal Societies. Neonatology. 2022;119(2):184-192.
6. Okulu E, Koç E, Erdeve Ö, et al. Neonatal resuscitation practices in Turkey: A survey of the Turkish neonatal society and the union of European neonatal and perinatal societies. Turk Arch Pediatr. 2023;58(3):289-297.
7. Gizzi C, Trevisanuto D, Gagliardi L, et al. Neonatal resuscitation practices in Italy: a survey of the Italian Society of Neonatology (SIN) and the Union of European Neonatal and Perinatal Societies (UENPS). Ital J Pediatr. 2022;48(1):81.
8. https://insse.ro/cms/sites/default/files/field/publicatii/evenimente_demografice_in_anul_2018.pdf
9. Geurtzen R, Van Heijst A, Hermens R, et al. Preferred prenatal counselling at the limits of viability: a survey among Dutch perinatal professionals. BMC Pregnancy Childbirth. 2018;18(1):7.
10. Griswold KJ, Fanaroff JM. An evidence-based overview of prenatal consultation with a focus on infants born at the limits of viability. Pediatrics. 2010;125(4):e931–7.
11. van den Heuvel JFM, Hogeveen M, Lutke Holzik M, van Heijst AFJ, Bekker MN, Geurtzen R. Digital decision aid for prenatal counseling in imminent extreme premature labor: development and pilot testing. BMC Med Inform Decis Mak. 2022;22(1):7.
12. Stanojevic M. Limits of viability: should we play God? Psychiatria Danubina. 2021;33(Suppl 3):S280-S291.
13. Aziz K, Lee HC, Escobedo MB, et al. Part 5: Neonatal Resuscitation: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2020;142:S524–S550.

14. Madar J, Roehr CC, Ainsworth S, et al. European resuscitation council guidelines 2021: newborn resuscitation and support of transition of infants at birth. Resuscitation. 2021; 161: 291-326.
15. Bruckner M, Lista G, Saugstad OD, Schmölzer GM. Delivery Room Management of Asphyxiated Term and Near-Term Infants. Neonatology. 2021;118(4):487-499.
16. Aker K, Støen R, Eikenes L, et al. Therapeutic hypothermia for neonatal hypoxic-ischaemic encephalopathy in India (THIN study): a randomised controlled trial. Arch Dis Child Fetal Neonatal. 2020;105:405-411.
17. Fogarty M, Osborn DA, Askie L, et al. Delayed vs early umbilical cord clamping for preterm infants: a systematic review and meta-analysis. Am J Obstet Gynecol. 2018 Jan;218(1):1-18.
18. Bhatt S, Alison BJ, Wallace EM, et al. Delaying cord clamping until ventilation onset improves cardiovascular function at birth in preterm lambs. J Physiol. 2013;591:2113–26.
19. Badurdeen S, Davis PG, Hooper SB, et al. Baby Directed Umbilical Cord Clamping (BabyDUCC) collaborative group. Physiologically based cord clamping for infants ≥32+0 weeks gestation: A randomised clinical trial and reference percentiles for heart rate and oxygen saturation for infants ≥35+0 weeks gestation. PLoS Med. 2022;19(6):e1004029.
20. Knol R, Brouwer E, van den Akker T, et al. Physiological-based cord clamping in very preterm infants - Randomised controlled trial on effectiveness of stabilisation. Resuscitation. 2020;147:26-33.
21. Foglia EE, Te Pas AB. Effective ventilation: the most critical intervention for successful delivery room resuscitation. Semin Fetal Neonatal Med. 2018;23:340–6.
22. Wyckoff MH, Greif R, Morley PT, et al. 2022 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations: Summary From the Basic Life Support; Advanced Life Support; Pediatric Life Support; Neonatal Life Support; Education, Implementation, and Teams; and First Aid Task Forces. Circulation. 2022;146(25):e483-e557.