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Neonatal Resuscitation Practices in Europe: A Survey of the Union of European Neonatal and Perinatal Societies

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Keywords
Europe · Neonatal resuscitation · Survey

Abstract
Background: We aimed to evaluate the policies and practices about neonatal resuscitation in a large sample of European hospitals. ***Methods:*** This was a cross-sectional electronic survey. A 91-item questionnaire focusing on the current delivery room practices in neonatal resuscitation domains was individually sent to the directors of 730 European neonatal facilities or (in 5 countries) made available as a Web-based link. A comparison was made between hospitals with ≤2,000 and those with >2,000 births/year and between hospitals in 5 European areas (Eastern Europe, Italy, Mediterranean countries, Turkey, and Western Europe). ***Results:*** The response rate was 57% and included participants from 33 European countries. In 2018, approximately 1.27

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million births occurred at the participating hospitals, with a median of 1,900 births/center (interquartile range: 1,400–3,000). Routine antenatal counseling ($p < 0.05$), the presence of a resuscitation team at all deliveries ($p < 0.01$), umbilical cord management ($p < 0.01$), practices for thermal management ($p < 0.05$), and heart rate monitoring ($p < 0.01$) were significantly different between hospitals with ≤2,000 births/year and those with >2,000 births/year. Ethical and educational aspects were similar between hospitals with low and high birth volumes. Significant variance in practice, ethical decision-making, and training programs were found between hospitals in 5 different European areas. ***Conclusions:*** Several recommendations about available equipment and clinical practices recommended by the international guidelines are already implemented by centers in Europe, but a large variance still persists. Clinicians and stakeholders should consider this information when allocating resources and planning European perinatal programs.

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Introduction

Significant physiological events occur during transition from intrauterine to extrauterine life [1]. Although most newly born infants are able to make this transition spontaneously, approximately 10% will require stimulation and drying to start breathing, 5% will need positive pressure ventilation, and 1–2% will undergo advanced resuscitation maneuvers [2–4]. In 2018, approximately 4.24 million babies were born in Europe [5]; of them, 400,000 needed some degree of help (i.e., stimulation), 200,000 received positive pressure ventilation, and approximately 50,000, advanced resuscitation. In Europe, there are about 5,000–20,000 asphyxiated neonates per year, and approximately half of them die or suffer neurodevelopmental impairment [6, 7].

Providing appropriate care at birth remains a crucial intervention for reducing neonatal mortality and morbidity [2, 3]. Knowledge on neonatal resuscitation practices in Europe could be the first step in designing a shared program on neonatal care at birth, measuring the impact on neonatal outcomes and creating a European collaborative network. The present study aimed to evaluate the practices on neonatal resuscitation in a large sample of European hospitals.

Methods

This is a cross-sectional electronic survey involving a large sample of European hospitals. The study received the approval from the Padua Provincial Institutional Review Board (protocol # 0035420) as not meeting criteria for human subject research. The presidents or secretaries of all National Neonatal Societies in Europe were emailed by the study coordinator on behalf of the president of the Union of European Neonatal and Perinatal Societies (UENPS), requesting the list of directors of the neonatal departments in their respective countries. Each director was then sent the Web-based survey by email link (www.surveymonkey.com). Participants were informed of the aims of the survey and that responses would be anonymized and encrypted before analysis. Completion of the survey was considered as informed consent for the respondents' participation. A reminder was sent to nonresponders every 2 weeks for a maximum of 3 times. At that point, if we had not received an answer, the participant was considered a nonresponder. In 5 countries (France, Germany, Israel, the Netherlands, and the UK), the link to the questionnaire was made available in the professional websites of National Neonatal Societies instead of being sent individually to directors of units. Participation was entirely voluntary. The survey was administered between October 2019 and September 2020.

The survey consisted of a 91-item questionnaire focusing on current DR practices in neonatal resuscitation domains [8]. It was broken down into the following sections: (a) epidemiological data, (b) perinatal organization, (c) equipment, (d) procedures, (e) ethics, and (f) education. The questionnaire was prepared by a committee of experts on neonatal resuscitation and members of the task force of the Neonatal Resuscitation of the Italian Society of Neonatology. The questions included multiple-choice, fill-in, and yes/no questions (online suppl. file; for all online suppl. material, see www.karger.com/doi/10.1159/000520617).

Statistics

Two independent investigators reviewed all returned questionnaires to avoid duplication of data. Data were examined with descriptive analyses. Categorical data were expressed as number and percentage and continuous data as median and interquartile range. Missing values were always <10%, except in 2 questions (see text and tables).

In the analysis, we compared hospitals with ≤2,000 births/year and hospitals with >2,000 births/year by using χ^2 tests. In addition, hospitals were grouped into 5 geographical areas (Eastern Europe, Italy, Mediterranean countries, Turkey, and Western Europe). Italy and Turkey were each considered separately due to the high number of participants. Eastern Europe included Albania, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Kazakhstan, Kosovo, Latvia, Lithuania, North Macedonia, Poland, Romania, Serbia, Slovakia, Slovenia, and Ukraine. Mediterranean countries included Greece, Israel, Portugal, and Spain. Western Europe included Austria, Finland, France, Germany, Ireland, the Netherlands, Norway, and the UK. Comparisons between the 5 European areas were performed using χ^2 tests. Statistical analysis was performed using Stata 15 statistical Package (Stata Corp, College Station, TX, USA).

Results

In total, the survey included participants from 33 European countries. Individual invitations were sent to 730 neonatologists and pediatricians identified as medical di-

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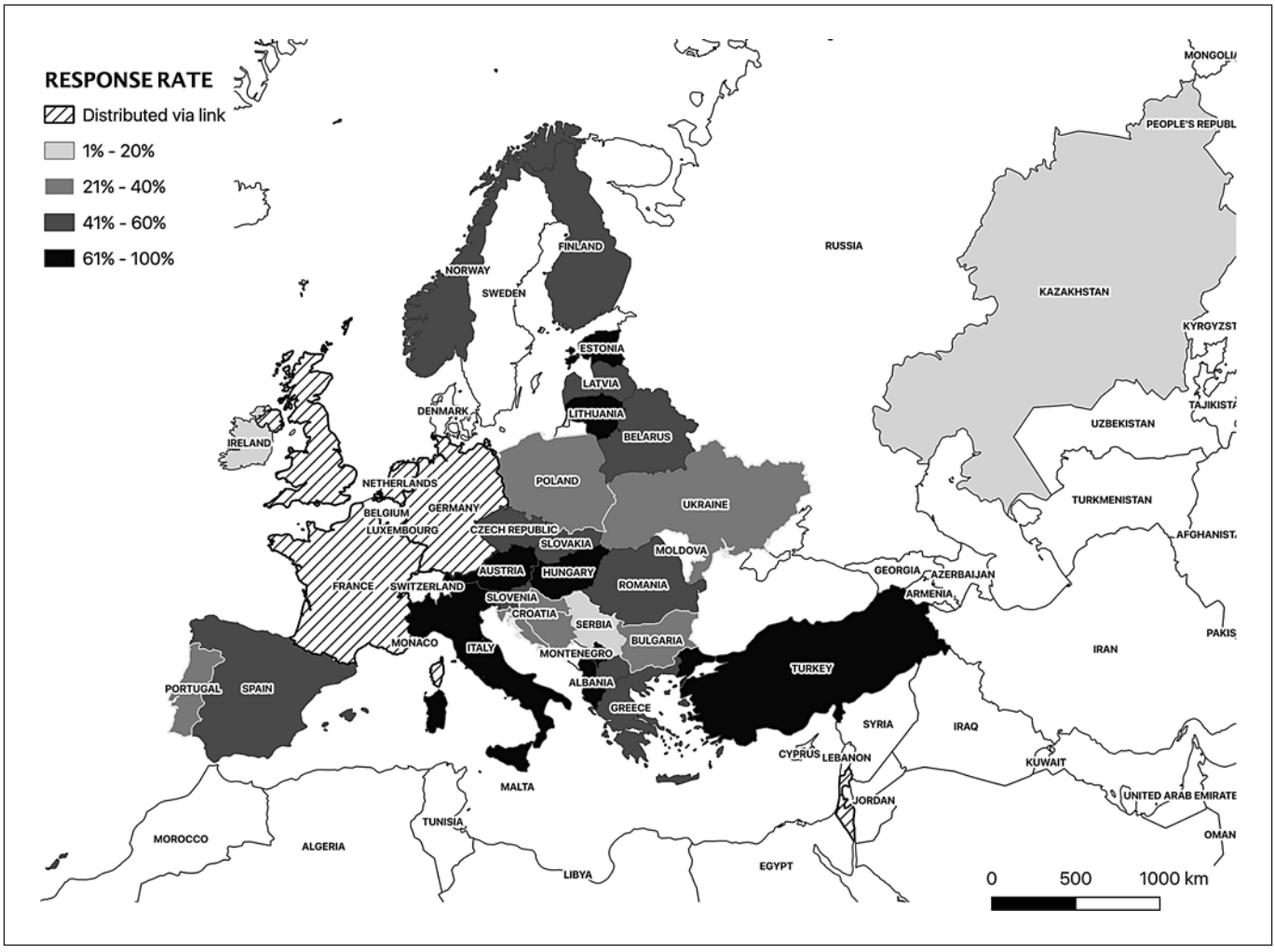

Fig. 1. Response rate by country.

rectors, and 414 answered (57%). In addition, we collected 32 responses from countries where invitations were made available as Web-based links – and therefore, the denominator and response rate could not be calculated.

Numbers and percentages of participating centers broken down by country are shown in online supplementary Table 1 and Figure 1. In 2018, approximately 1,275 million births occurred at the participating hospitals, with a median of 1,900 births/center (interquartile range: 1,400–3,000). Participating hospitals were able to provide nasal CPAP and/or high-flow nasal cannulae (97%), mechanical ventilation (88%), HFOV (71%), inhaled nitric oxide (54%), therapeutic hypothermia (54%), and extracorporeal membrane oxygenation (9%). Of the participating centers, 268 (60%) were academic hospitals.

Comparison between Hospitals with >2,000 Births/Year and Hospitals with ≤2,000 Births/Year

The percentages of both academic hospitals and hospitals with a NICU were higher in centers with >2,000 births/year compared to those with ≤2,000 births/year ($p < 0.01$) (Table 1). Table 1 shows the results on the organizational aspects and umbilical-cord management. Hospitals with ≤2,000 births/year and those with >2,000 births/year were significantly different in the availability of routine antenatal counseling ($p < 0.05$), the presence of a resuscitation team at all deliveries ($p < 0.01$), and resuscitation with an intact umbilical cord ($p < 0.01$). Some approaches for preventing heat loss were significantly different between hospitals with ≤2,000 births/year and hospitals with >2,000 births/year; these approaches included increasing delivery

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Table 1. Characteristics of the hospitals, organizational aspects, and umbilical-cord management

	Total (*n*, 446)	Hospitals with ≤2,000 births/ year (*n*, 244)	Hospitals with >2,000 births/ year (*n*, 202)
Academic hospitals	268 (60)	113 (46)	155 (77)*
Hospitals with a neonatal intensive care unit	380 (85)	185 (75)	195 (96)*
Organizational aspects			
Antenatal counseling	345 (77)	178 (73)	167 (83)§
Presence of a resuscitation team at all deliveries	219 (49)	134 (54)	85 (42)*
Use of the checklist	401 (90)	220 (90)	181 (88)
(a) Umbilical cord management, term vaginal delivery			
Delayed cord clamping (>30 s after birth)	272 (61)	147 (60)	125 (62)
Physiologically based cord clamping (delay until pulsation ceases)	104 (23)	59 (24)	45 (22)
Immediate cord clamping	31 (7)	19 (8)	12 (6)
Umbilical cord milking	23 (5)	10 (4)	13 (6)
NA	16 (4)	9 (4)	7 (4)
(b) Umbilical cord management, term elective CS			
Delayed cord clamping	234 (52)	115 (47)	119 (59)
Physiologically based cord clamping	56 (13)	35 (14)	21 (10)
Immediate cord clamping	111 (25)	69 (28)	42 (21)
Umbilical cord milking	25 (6)	15 (6)	10 (5)
NA	20 (5)	10 (4)	10 (5)
Resuscitation with an intact umbilical cord	80 (18)	31 (13)	49 (24)*

Data are expressed as *n* (%). * $p < 0.01$. § $p < 0.05$.

Table 2. Initial steps

	Total (*n*, 446)	Hospitals with ≤2,000 births/ year (*n*, 202)	Hospitals with >2,000 births/ year (*n*, 244)
(a) Thermal management			
Increasing the delivery room temperature	177 (40)	84 (34)	93 (46)§
Preheating the infant warmer	380 (85)	198 (81)	182 (90)*
Plastic bag/wrap	355 (80)	193 (79)	162 (80)
Servo-controlled temperature probe	177 (40)	80 (32)	97 (48)*
Thermal mattress	108 (24)	57 (23)	51 (25)
Cap	287 (64)	144 (59)	143 (71)*
Pre-warmed towels	316 (71)	164 (67)	152 (75)
Heated/humidified gases	166 (37)	91 (37)	75 (37)
(b) Heart rate assessment			
Stethoscope	349 (78)	195 (80)	154 (76)
3-lead ECG	142 (32)	67 (27)	75 (37)§
Umbilical cord palpation	108 (24)	51 (21)	57 (28)
Palpation of peripheral pulses	17 (4)	7 (3)	10 (5)

Data are expressed as *n* (%). * $p \leq 0.01$. § $p < 0.05$.

room temperature ($p < 0.05$), preheating the infant warmer ($p < 0.01$), use of the servo-controlled temperature probe ($p < 0.01$) and the cap ($p < 0.01$), the use of the 3-lead ECG ($p < 0.01$), and surfactant administration in the delivery room ($p < 0.05$) (Tables 2, 3). Ethical and educational aspects were similar between hospitals with ≤2,000 births/year and hospitals with >2,000 births/year (Table 4).

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Table 3. Ventilation and oxygen therapy

	Total (*n*, 446)	Hospitals with ≤2,000 births/ year (*n*, 244)	Hospitals with >2,000 births/ year (*n*, 202)
(a) Equipment			
Air/oxygen blender	404 (91)	224 (92)	180 (89)
Pulse oximeter	410 (91)	228 (93)	182 (90)
Laryngeal mask	249 (56)	143 (59)	106 (52)
End-tidal CO2 detector	85 (19)	38 (16)	47 (23)
Respiratory function monitoring	88 (20)	48 (20)	40 (20)
(b) Initial ventilation with…			
T-piece resuscitator	352 (79)	197 (81)	155 (77)
Self-inflating bag	38 (9)	21 (9)	17 (8)
Flow-inflating bag	8 (2)	4 (2)	4 (2)
Other	24 (5)	11 (4)	13 (6)
NA	24 (5)	11 (6)	13 (7)
(c) Interfaces for starting PPV			
Face mask	324 (73)	182 (75)	142 (70)
Short binasal prongs	86 (19)	44 (18)	42 (21)
Nasopharyngeal prong or ETT	11 (2)	1 (0)	3 (2)
Laryngeal mask	1 (0.2)	1 (0)	0 (0)
NA	24 (5)	11 (5)	13 (6)
(d) Initial FiO2			
Infants with gestational age <35 weeks			
0.21–0.29	186 (42)	106 (44)	80 (40)
0.30	213 (48)	111 (45)	102 (50)
>0.30	17 (4)	13 (5)	4 (2)
Missing	30 (7)	14 (6)	16 (8)
Infants with gestational age ≥35 weeks			
0.21–0.29	382 (86)	211 (86)	171 (86)
0.30	27 (6)	12 (5)	15 (7)
>0.30	11 (2)	9 (4)	2 (1)
Missing	26 (6)	12 (5)	14 (6)
(e) Level of CPAP, cm H2O			
≤4	29 (6)	19 (8)	10 (6)
5	252 (56)	144 (59)	108 (53)
6	112 (26)	54 (23)	58 (28)
>6	17 (4)	9 (3)	8 (4)
NA	36 (8)	18 (7)	18 (9)
(f) Level of PEEP, cm H2O			
≤4	42 (9)	24 (10)	18 (9)
5	295 (66)	164 (67)	131 (65)
6	77 (17)	41 (17)	36 (18)
>6	4 (1)	2 (1)	2 (1)
NA	28 (6)	13 (5)	15 (7)
(g) Initial peak inspiratory pressure, cm H2O			
<20	91 (20)	53 (23)	38 (19)
20	211 (47)	117 (47)	94 (47)
25	90 (20)	46 (19)	44 (22)
30	24 (5)	13 (5)	11 (5)
Other	30 (7)	15 (6)	15 (7)
(h) Sustained lung inflation			
Never	274 (61)	139 (57)	135 (67)
Yes, occasionally	70 (16)	39 (16)	31 (15)
Yes, routinely	49 (11)	29 (12)	20 (10)
NA	53 (12)	37 (15)	16 (8)

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Table 3 (continued)

	Total (*n*, 446)	Hospitals with ≤2,000 births/ year (*n*, 244)	Hospitals with >2,000 births/ year (*n*, 202)
(i) Infant born through meconium stained amniotic fluid			
Start PPV	336 (75)	186 (76)	150 (74)
Intubation and suctioning	59 (13)	28 (11)	31 (15)
Suctioning before	30 (7)	19 (8)	11 85)
NA	21 (5)	11 (5)	(10 5)
(l) Surfactant in the delivery room			
Yes	209 (47)	101 (41)	108 (53)[§]
No	205 (46)	126 (52)	79 (39)
NA	32 (7)	17 (7)	15 (7)
(m) Caffeine in the delivery room			
Yes	49 (11)	22 (9)	27 (13)
No	365 (82)	205 (84)	160 (79)
NA	32 (7)	17 (7)	15 (7)

Data are expressed as *n* (%). PPV, positive pressure ventilation. [§] $p < 0.05$.

Comparison between Hospitals in Relation to the European Area (Eastern Europe, Italy, Mediterranean countries, Turkey, and West Europe)

The percentages of academic hospitals, hospitals with a NICU, organizational aspects, and management of the umbilical cord were different between hospitals in different European areas ($p < 0.01$) (online suppl. Table 2). Results by the geographic area concerning initial steps, ventilation and oxygen therapy, ethics, and educational aspects are reported in online supplementary Tables 3–5.

Discussion

This survey provides insight into neonatal resuscitation practices in a large sample of European hospitals. Some parts of local equipment and practices recommended by the international guidelines are taken over by centers in Europe, but divergences in perinatal care, respiratory support, ethics, and training programs between participating centers still persist.

Differences between hospitals with low and high birth volumes were mainly limited to some organizational aspects (i.e., antenatal counseling and the presence of a resuscitation team at all deliveries) or to the initial steps (i.e., thermal management and use of the 3-lead ECG), while differences in many resuscitation practices were found between hospitals in different European areas. Our results show that the availability of a routine antenatal counseling was more frequently offered in hospitals with ≥2,000 births/year compared to those with <2,000 births/year. This finding may be explained by the fact that academic hospitals and hospitals equipped with a NICU were more frequently represented in high birth volume centers where it is likely that the sickest neonates with more complex diseases are cared for.

The presence of a resuscitation team at all deliveries was more frequently reported in low than in high birth volume hospitals; significant variance regarding this organizational aspect was also found among hospitals form different European areas. Further studies should consider a cost/benefit analysis on the utilization of human resources in the delivery room in relation to neonatal outcomes.

Delayed or physiologically based delayed cord clamping is provided to most term infants, both from vaginal and caesarean delivery, suggesting that this low-cost, effective intervention has been fully implemented in these categories of patients in Europe [2, 3, 9–11]. Providing resuscitation with an intact umbilical cord at the mother's bedside seems to be a reasonable approach, but clinical data are still scarce and further confirmation is needed [2, 3]. Nevertheless, it is provided in approximately one-fifth of centers, showing that some European neonatologists believe in the benefits of this practice. Of note, resuscitation with an intact umbilical cord was more frequently performed in hospitals with high birth volumes, and this was more likely if the center was an academic hospital or a center where a higher number of high-risk deliveries are referred.

Both hypo- and hyperthermia immediately after birth are associated with mortality and morbidity in preterm

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Table 4. Ethics and education

	Total (*n*, 446)	Hospitals with ≤2,000 births/ year (*n*, 244)	Hospitals with >2,000 births/ year (*n*, 202)
Ethics			
(a) In your center, do you have a gestational age limit for initiating resuscitation/ stabilization interventions			
Yes	280 (63)	143 (57)	137 (68)
No	125 (28)	78 (32)	47 (23)
NA	41 (9)	23 (9)	18 (8)
(b) In your center, do you have a time limit for stopping resuscitation interventions?			
Yes	259 (58)	138 (57)	121 (61)
No	146 (33)	85 (35)	61 (30)
I do not know	13 (3)	8 (3)	5 (2)
NA	28 (6)	13 (5)	15 (7)
(c) Does parental opinion influence your resuscitation interventions			
Yes	161 (36)	78 (32)	83 (41)
A little bit	123 (28)	75 (31)	48 (24)
Not at all	124 (28)	70 (29)	54 (27)
I do not know	11 (2)	8 (3)	3 (1)
NA	27 (6)	13 (5)	14 (7)
Education			
(a) Are courses on neonatal resuscitation regularly held at your hospital?			
Yes	358 (80)	194 (80)	164 (81)
No	61 (14)	37 (15)	24 (12)
NA	27 (6)	13 (5)	14 (7)
(b) Which algorithm for neonatal resuscitation does your institution follow?			
AHA and AAP	178 (40)	103 (42)	75 (37)
ERC	77 (17)	40 (16)	37 (18)
National guidelines	86 (19)	42 (18)	44 (22)
Other	17 (4)	7 (3)	210 (5)
I do not know	2 (1)	2 (1)	0 (0)
NA	86 (19)	50 (20)	36 (18)
(c) Your team is retrained every…			
<6 months	39 (9)	26 (11)	13 (6)
6–12 months	119 (27)	65 (27)	54 (27)
12–24 months	174 (39)	99 (40)	73 (36)
>24 months	89 (20)	41 (17)	48 (24)
NA	27 (6)	13 (5)	14 (7)

Data are expressed as *n* (%).

and term infants [12–14]. A series of interventions to reduce mortality and morbidity from hypo- and hyperthermia, including adequate delivery room temperature, the use of plastic bags or wraps, cap, pre-warmed mattress, and heated humidified gases, have been recommended to achieve this goal [2, 3]. Our findings show that most participating hospitals adopt such interventions, but some (e.g., heated and humidified gases) need to be further implemented. Some approaches (increasing delivery room temperature, preheating the infant warmer, and use of the servo-controlled temperature probe and the cap) for preventing heat loss were more frequently used in hospitals with >2,000 births/year than in those with ≤2,000 births/year mirroring the different neonatal populations cared for in these centers.

The heart rate is the most important indicator during neonatal resuscitation [2, 3, 15]. Although umbilical cord palpation has been demonstrated to be unreliable for detecting the heart rate, approximately a quarter of surveyed hospitals embrace this practice. A 3-lead ECG is used in only a quarter of centers, showing limited adherence to the latest version of the American and European Guidelines, which recommend its use in infants needing advanced resuscitation [3, 16]. Not surprisingly, the 3-lead ECG was most frequently used in large birth volume hospitals.

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Overall, European hospitals declared that they have the appropriate equipment (e.g., air/oxygen blender and T-piece resuscitator) to provide effective ventilation during neonatal resuscitation despite significant differences being reported between hospitals in different European areas. Such discrepancies may be for economic, cultural, or educational reasons, which merit further analysis.

Ethical issues represent an essential aspect for caregivers involved in neonatal resuscitation practices and parents [17–19]. Our survey shows that guidelines aiming to support the personnel involved in these difficult decisions are still lacking in about 30% of European hospitals. Also, the involvement of parents in the decision-making process is still limited. Our findings are in agreement with previous studies assessing ethical aspects among European neonatologists [20, 21]. This remains a delicate field that needs further research to help neonatal staff and parents deal with these difficult situations. Approaches to ethical issues were comparable between hospitals with low and high birth volume, but they changed significantly between hospitals in the different European areas, suggesting that cultural aspects have an important role in these situations.

Although courses on neonatal resuscitation were routinely offered in most surveyed hospitals (80%), the training programs varied between centers, with the Neonatal Resuscitation Program being the most widely used [15]; however, there was a very high frequency (19%) of nonresponse to this question. Both the educational programs themselves and the frequency with which they were held varied between the hospitals in different European areas. A standard European training program addressing the contents and frequency of retraining in neonatal resuscitation should be considered. The strengths of the present study include (i) the structured questionnaire used in previous studies, prepared by a group of experts, that assesses several areas of neonatal resuscitation; (ii) the large sample of hospitals representing 33 European countries, where about a quarter of all European deliveries occurred in 2018; and (iii) the use of an online survey.

This study has some limitations that should be recognized. First, although there was a good response rate from participating countries, the contribution of some European countries was lacking or very limited. Second, as participants were arbitrarily divided into 5 groups based on the number of participants and the geographic area, the differences between groups should be interpreted with caution. Third, only 33 out of the 47 European countries responded to the survey, limiting the generalizability of the findings. Fourth, as only the directors of the neonatal wards were involved, the results may mirror the opinions of this very restricted group of clinicians and not actual clinical practice in each hospital; however, the questionnaire was structured with the aim of obtaining objective information about specific points that are detailed in international recommendations, and the answers obtained can be taken as reflecting at least the policy of each hospital. Our findings may become the basis to guide clinicians and stakeholders in the development of future analytical tools, including standard guidelines, outcome monitoring, and collaborative research programs on the care of infants at birth in Europe [22].

Conclusions

This survey provides insight into neonatal resuscitation practices in a large sample of European hospitals. Overall, several recommendations about available equipment and clinical practices recommended by the international guidelines are already implemented by centers in Europe, but discrepancies in perinatal care, respiratory support, ethics, and training programs among participating centers still persist. Clinicians and stakeholders should consider this information when allocating resources and planning European perinatal programs.

Acknowledgments

We are very grateful to the UENPS Study Committee and to the directors of Neonatal and Pediatric Departments who participated in the survey (online suppl. file 2).

Statement of Ethics

The study received the approval from the Padua Provincial Institutional Review Board (protocol # 0035420) as not meeting criteria for human subject research.

Conflict of Interest Statement

The authors have no potential conflicts of interest to disclose.

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The authors have no financial relationship relevant to this article to disclose.

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Author Contributions

Dr. Trevisanuto contributed to the study concept and preparation of the survey, wrote the initial draft, and critically reviewed the manuscript. Dr. Gizzi contributed to the study concept, preparation of the survey, and writing of the manuscript and critically reviewed the manuscript. Dr. Gagliardi contributed to the study concept, data analysis, and writing of the manuscript and critically reviewed the manuscript. Dr. Ghirardello, Dr. Di Fabio, Dr. Beke, and Dr. Buonocore contributed to the study concept, data curation, and writing the draft of the manuscript and critically reviewed the manuscript. Dr. Charitou, Dr. Cucerea, Dr. Degtyareva, Dr. Filipović-Grčić, Dr. Jekova, Dr. Koç, Dr. Saldanha, Dr. Sanchez Luna, and Dr. Stoniene contributed to the study concept, data collection, and writing the draft of the manuscript and critically reviewed the manuscript. Dr. Vertecchi coordinated the contacts with participating centers; contributed to the study concept, data curation, and writing the draft of the manuscript; and critically reviewed the manuscript. Dr. Mosca contributed to the study concept and to writing the draft of the manuscript, provided relevant expertise, and critically reviewed the manuscript. Dr. Moretti contributed to the study concept and to writing the draft of the manuscript, provided relevant expertise, and critically reviewed the manuscript. All the authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Data Availability Statement

All data generated or analyzed during this study are included in this article and its online supplementary material. Further inquiries can be directed to the corresponding author.

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