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Original Research

Prehospital Management of Peripartum Neonatal Complications by Helicopter Emergency Medical Service in the South West of the Netherlands: An Observational Study

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A B S T R A C T

Objective: Emergency medical service (EMS) is responsible for prehospital care encompassing all ages, irrespective of injury cause or medical condition, which includes peripartum emergencies. When patients require care more advanced than the level provided by the national EMS protocol, an EMS physician-staffed Dutch helicopter emergency medical service (HEMS) may be dispatched. In the Netherlands in 2016, there were 21.434 planned home births guided by midwives alone without further obstetric assistance, accounting for 12.7% of all births that year. However, there are no clear data available thus far regarding neonates requiring emergency care with or without HEMS assistance. This article reviews neonates during our study period who received medical care after birth by HEMS.

Methods: A retrospective chart review was performed including neonates born on the day of the dispatch between January 2012 and December 2017 who received additional medical care from the Rotterdam HEMS.

Results: Fifty-two neonates received medical care by HEMS. The majority (73.1%) were full-term (Gestational age > 37 weeks). Home delivery was intended in 63.5%, 20% of whom experienced an uncomplicated delivery but had a poor start of life. The majority of unplanned deliveries (n = 17) were preterm (70.6%). Two were born by resuscitative hysterotomy; 1 survived in good neurologic condition, and the other died at the scene. Fifteen neonates (28.9%) required cardiopulmonary resuscitation; in 2 cases, no resuscitation was started on medical grounds, and 12 of the other 13 resuscitated neonates regained return of spontaneous circulation. In 33 (63.5%) of the neonates, respiratory interventions were required; 8 (15.4%) were intubated before transport. Death was confirmed in 5 (9.6%) neonates, all preterm.

Conclusion: During the study period, 52 neonates required medical assistance by HEMS. The 5 infants who died were all preterm. In this cohort, adequate basic life support was implemented immediately after birth either by the attending midwife, EMS, or HEMS on arrival. This suggests that prehospital first responders know the basic skills of neonatal life support.

Little is currently known regarding neonates receiving urgent medical care by an emergency medical service (EMS) and/or a physician-staffed helicopter emergency medical service (HEMS) in the Netherlands. In our country, HEMS is responsible for urgent medical care for patients of all ages and types of injury or illness.

In cases concerning neonates, HEMS is deployed in addition to EMS by the dispatcher if a complicated planned or unplanned home delivery, an injured or seriously ill pregnant woman, or a critically ill neonate is reported. In case the situation is under control by the standard procedures and can be managed according to the Dutch nationwide ambulance protocol before HEMS is at the scene, the EMS crew can cancel HEMS assistance according to the cancel criteria.[1]

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In the Netherlands, HEMS is staffed by a senior anesthesiologist or trauma surgeon with a specialized nurse and a helicopter pilot. Every HEMS physician is minimally trained in advanced pediatric life support and receives additional training on neonatal life support during his or her annual training day. HEMS nurses are trained in neonatal life support and prehospital pediatric life support.

The EMS crew in the Netherlands is staffed by a specialized nurse with training in pediatric life support during his or her basic training. Each EMS nurse is assisted by a paramedic who drives the ambulance and is trained to assist the nurse.

The international literature shows a range of prehospital (planned and unplanned) deliveries of 0.0006% to 1.99%.[2-4] Historically, in the Netherlands, more women chose a home delivery[5,6] compared with Norwegian women (0.2%)[7] and Belgian women (1%).[8] In 2016, 12.7% Dutch deliveries were planned home births guided by specialized registered midwives, and an additional 17.3% delivered their child under the guidance of their midwife in a birth center attached to a hospital where an obstetrician, pediatrician, and anesthetist were directly available.[5]

Only women without any risk factors during their pregnancy are eligible for planned home delivery in the Netherlands.[9] In case of (suspected) complications during labor or a request for (epidural) pain relief, the patient is transferred to a nearby hospital.

In the Rotterdam HEMS dispatch region, there were approximately 40,000 to 45,000 deliveries in 2015.[6] Considering a planned home birth rate of 13%, there are around 5,000 to 5,500 home deliveries in this dispatch region each year.[4,5]

In the Netherlands, previous studies showed no difference in neonatal mortality in low-risk pregnancies for planned home births compared with obstetrician-led childbirth in a hospital.[10,11] Earlier international studies showed that peripartum mortality is higher in the group of unplanned prehospital deliveries compared with hospital deliveries[12]; the neonates who were deceased were of lower birth weight and had a lower gestational age.[2,7]

Our goal was to gain a greater understanding of the frequency and nature of prehospital neonatal emergencies in order to subsequently develop appropriate first responder training material and equipment requirements. The Medical Ethical Committee of the Erasmus University Medical Center (MEC-2018-1375) approved this study.

Methods

This study was a retrospective database review of the Rotterdam HEMS, which included all patients born on the day of the dispatch between January 2012 and December 2017. Deployments canceled before the HEMS crew had seen the patient are excluded from this database. The charts were reviewed on patient demographics, (estimated) gestational age, (estimated) birth weight, prehospital interventions, and, if available, hospital follow-up and mortality.

From the patients not deceased during the initial assessment by the HEMS crew, we requested the information from the Dutch register of the “Gemeentelijke Basis Registratie” (GBA) registering all citizens by name, sex, date of birth, and, if applicable, date of demise. This information was obtained on June 18, 2018.

All data were analyzed using descriptive statistics with SPSS Statistics Version 24.0.0.1 (IBM Corp, Armonk, NY).

Results

During the 6-year research period, there were 1,905 pediatric patients receiving medical care from the Rotterdam HEMS. Of these, 52 (2.7%) were born on the day of the dispatch (fig 1).

Patient Characteristics

Patient characteristics are depicted in Table 1. Of the 52 patients, 38 patients (73.1%) were full-term (gestational age > 37 weeks). Gestational age was noted by the HEMS physician in the chart and verified in hospital records if available. There was a normal birth weight of ≥ 2,501 g or more in 26 (50%) of the infants. In 16 (30.8%) of the patients, no record was found of an estimated birth weight.

Table 1
Patient Characteristics

	N = 52	%
Sex		
Male	28	53.8
Female	23	44.2
Unknown	1	1.9
Full-term (≥ 37 weeks of gestation)		
Yes	38	73.1
No	12	23.1
Unknown	2	3.8
Birth weight		
ELBW (≤ 1,000 g)	6	11.5
VLBW (1,001-1,500 g)	2	3.8
LBW (1,501-2,500 g)	2	3.8
Normal (≥ 2,501 g)	26	50.0
Unknown	16	30.8

ELBW = extremely low birth weight; LBW = low birth weight; VLBW = very low birth weight.
ELBW, ≤ 1,000 g; VLBW, 1,001 to 1,500 g; LBW, 1,501 to 2,500 g; and normal, ≥ 2,501 g.

Intended Location of Delivery

A home birth was intended in 33 (63.5%) of the patients; obstetric data are shown in Table 2. In 1 case, the home delivery was against medical advice because of a known breech position; all others were considered low-risk deliveries. Of the 17 (32.7%) unplanned out-of-hospital births, 2 mothers did not know they were pregnant and did not receive prenatal care. In 3 patients, delivery was planned in the hospital; however, the labor was progressing too rapidly for transport.

Resuscitative hysterotomy was performed for 2 patients by the Rotterdam HEMS crew.

One mother was found in asystole of unknown origin and duration. Hysterotomy was performed on HEMS arrival, 16 minutes after the initial call. At birth, the infant was in asystole and did not regain return of spontaneous circulation (ROSC).

The second mother complained of severe abdominal pain and vaginal bleeding before the witnessed arrest. Basic life support (BLS) was implemented immediately by the spouse, and the resuscitative hysterotomy was performed immediately after the arrival of the Rotterdam HEMS, 12 minutes after the initial call. The child regained

Table 2
Obstetric Data

	N	%
Planned home birth	33	63.5
Prolonged labor	5	
Breech	2	
Umbilical cord strangulation	5	
Meconium	2	
Shoulder dystocia	4	
Precipitous labor	2	
Partial abruption placentae	1	
Fetal bradycardia during delivery	1	
Normal delivery	6	
Labor not documented	7	
Unplanned out-of-hospital birth	17	32.7
Resuscitative hysterotomy	2	
Precipitous labor	5	
Preterm labor	12	
Breech	1	
Unknown pregnancy	2	
Unknown intended location of delivery	2	3.8

Table 3
Prehospital Interventions and Medication

	Overall, n (%)	Planned Home Delivery (n = 33), n	Unplanned Home Delivery (n = 17), n	Unknown (n = 2), n
Respiratory support				
Only rescue breaths	6 (11.5)	6	0	0
Mechanical ventilation (bag/mask or endotracheal)	20 (38.5)	8	11	1
Intubation	8 (15.4)	1	7	0
Cardiopulmonary resuscitation	15 (28.9)	6	9	
ROSC	12 (23.1)	6	6	
No ROSC	1 (1.9)	0	1	
No resuscitation started	2 (3.8)	0	2	
Medication EMS		3	1	
Adrenaline	1 (1.9)	0	1	
Glucose	3 (5.8)	3	0	
Medication HEMS				
None	42 (80.8)	29	13	0
Adrenaline	2 (3.8)	0	2	0
Atropine	1 (1.9)	1	0	0
Fentanyl	1 (1.9)	0	1	0
Midazolam	1 (1.9)	0	1	0
Glucose	6 (11.5)	3	2	1

EMS = emergency medical services; HEMS = helicopter emergency medical services; ROSC = return of spontaneous circulation.

ROSC 7 to 10 minutes after birth and has a normal neurologic development at 2 years of age. Both mothers died at the scene.

Prehospital Interventions

The HEMS physician noted in the charts that for all patients the necessary medical interventions were performed directly by the attending midwife or in case of an unguided delivery by EMS or HEMS on arrival. In 19 (36.5%) of the patients, no respiratory or cardiopulmonary interventions were necessary Table 3.

Six neonates were intubated as part of cardiopulmonary resuscitation (CPR). One was intubated because of prolonged bradycardia despite adequate bag mask ventilation and recovered after intubation without thoracic compressions. The last child was intubated because of respiratory insufficiency caused by suspected shunting due to maternal medication use; the mother used a selective serotonin reuptake inhibitor during pregnancy. This infant received midazolam and fentanyl to facilitate intubation.

In 15 cases, bradycardia < 60 beats/min or asystole was the initial rhythm. In 2 patients, CPR was not started by HEMS on medical grounds. One infant was born alive with an estimated gestation of 16 to 20 weeks and a 400-g birth weight. The other was born in asystole at 24 + 0 weeks of gestation with dysmaturity, a birth weight of 400 g, and dysmorphias. Of the 13 cases of CPR, ROSC was achieved in 12. One child received 3 doses of adrenaline nasally by the EMS crew but no further medication by HEMS. Two other patients received adrenaline intravenously by HEMS.

Table 4
Mortality

	N	%
Deceased < 1 year (n = 52)		
Yes	5	9.6
No	14	26.9
Unknown	33	63.5
Deceased/gestation		
Preterm	5 (n = 12)	41.7
Full-term	0 (n = 38)	0
Unknown	0 (n = 2)	0
Deceased/birth weight		
ELBW	2 (n = 6)	33.3
VLBW	2 (n = 2)	100
LBW	0 (n = 2)	0
Normal	0 (n = 26)	0
Unknown	1 (n = 16)	6.3
Deceased/planned location		
Planned home birth	0 (n = 33)	0
Unplanned	5 (n = 17)	32.7
Unknown	0 (n = 2)	0
Deceased/resuscitation		
Thoracic compressions	3 (n = 13)	23.1
No resuscitation started	2 (n = 2)	100
No thoracic compressions	0 (n = 37)	0
Deceased/intubation		
Intubation	2 (n = 8)	25
No intubation	3 (n = 44)	14.6

ELBW = extremely low birth weight; LBW = low birth weight; VLBW = very low birth weight.

Care After Delivery and Initial Stabilization

The HEMS crew determines the appropriate hospital and mode of transport for their patients (Fig. 2). The EMS crew requested HEMS assistance during the transport of 2 patients. None of these patients were transported by helicopter, which is typical in our country because of the short distances to an appropriate hospital.

In the Netherlands, 10 hospitals have a level 3 neonatal intensive care unit (NICU) available. In the study cohort, 24 (46.2%) of the newborns were transported to a hospital with a NICU available. Sixteen were transported to Erasmus University Medical Center Rotterdam-Sophia Children's Hospital, the only NICU in the South West of the Netherlands. One was transported to a NICU in Belgium because that was the nearest hospital.

Mortality

From this cohort, 5 neonates died confirmed by demise either during the initial assessment by HEMS or during their hospital stay. Of 13 children, we were unable to obtain data concerning mortality for the GBA because of insufficient demographic data in the medical chart.

Of the 5 neonates who died, the 2 who died at the scene were extremely low birth weight and extremely premature. No resuscitative measures were started on medical grounds by judgment of the HEMS physician Table 4.

One died on arrival at the hospital after secondary deterioration despite all resuscitative measures. This child was born at 24 + 3 weeks; there was anhydramnios due to premature prolonged rupture of membranes since week 18 of gestation. One neonate died after cardiopulmonary arrest in the mother; this child was born at 32 + 0 weeks of gestation by resuscitative hysterotomy. The last infant was born at 29 + 6 weeks with asystole at birth. This child regained ROSC

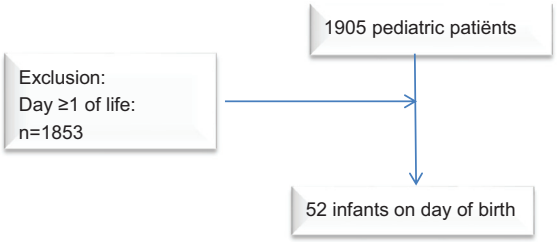

Figure 1. Inclusion/exclusion.

after 20 minutes of CPR but died 1 day later in the NICU after withdrawal of care because of severe neurologic damage.

Discussion

To our knowledge, this is the first study reviewing HEMS assistance in neonatal emergencies on the day of birth in the Netherlands. During the study period, we found no mortality among the planned prehospital deliveries and unplanned full-term prehospital deliveries. However, we were unable to obtain GBA data on all children.

The infants who died in this cohort had a very poor prognosis to start; all were preterm and required CPR directly after birth. Previous studies also showed that mortality was related to the preterm infant with a low birth weight.[2,7]

There are strict criteria for home deliveries in our country; only women with no predetermined risk factors for complications during labor are eligible to start elective delivery at home.[9] The risk for urgent referral due to complications before or during labor in home deliveries is low (ie, 0.4% of all deliveries in the Netherlands).[13] Because of the short distances by road to a hospital, this is usually not a problem.

These strict criteria and the transfer to a hospital during labor might be an explanation why there were only 52 dispatches from an estimate of 30,000 to 35,000 planned home deliveries. Furthermore, this is a possible sign that home deliveries can be safe with the right safety measures. Another possibility is that these 52 are just the tip of the iceberg, considering the lack of data regarding resuscitation or lifesaving interventions in the newborn without HEMS dispatch.

After normal delivery, approximately 5% to 10% of infants require some type of assistance after birth, such as bag mask ventilation for successful transition.[14] A previous study showed that approximately 6.4% of the neonates born by unplanned out-of-hospital delivery require prehospital resuscitation, and 14.8% require a form of airway management.[3]

As expected because of the dispatch criteria, this cohort shows a much higher incidence (63.5%) of patients requiring any respiratory support; 15.4% of patients required endotracheal intubation in the prehospital setting. In the Netherlands, HEMS expertise is required for neonatal intubation; this has been removed from the EMS protocol because of limited exposure. EMS does provide bag and mask ventilation, and it is known that training improves the effectiveness of this procedure.[15,16]

CPR is rare after a normal delivery and occurs in less than 0.5% of deliveries.[2] As expected because of dispatch criteria, we found a much higher incidence (28.9%) of patients requiring CPR by HEMS. The high success rate of resuscitation in this cohort is potentially caused by the very short delay or no delay to start resuscitative measures by the attending midwife, EMS, or HEMS, depending on who is first at the scene.

In the Netherlands, the training of midwives includes neonatal BLS, and they are required to train in BLS at least 20 hours every 5 years to maintain their license. Their training provides a bridge of care while awaiting the arrival of EMS or HEMS who are trained in advanced life support.

Mandatory basic equipment for midwives includes a ventilation bag and masks suitable for a newborn, an 0.8-L tank of oxygen, suction equipment, and a gastric tube.[17] We found in the HEMS charts that when BLS was started immediately by the first responder, the situation was considerably different compared with a study of unplanned prehospital deliveries in Texas where up to 75% did not receive any resuscitative interventions at all, such as oxygen or bag mask ventilation, until they reached the hospital, resulting in more cardiopulmonary arrests.[2] Although no data are available to determine the effectiveness of paramedic airway management in the newborn baby,[3] it is obvious that withholding or postponing resuscitative measures can lead to deterioration of the neonate's condition and eventually to death.

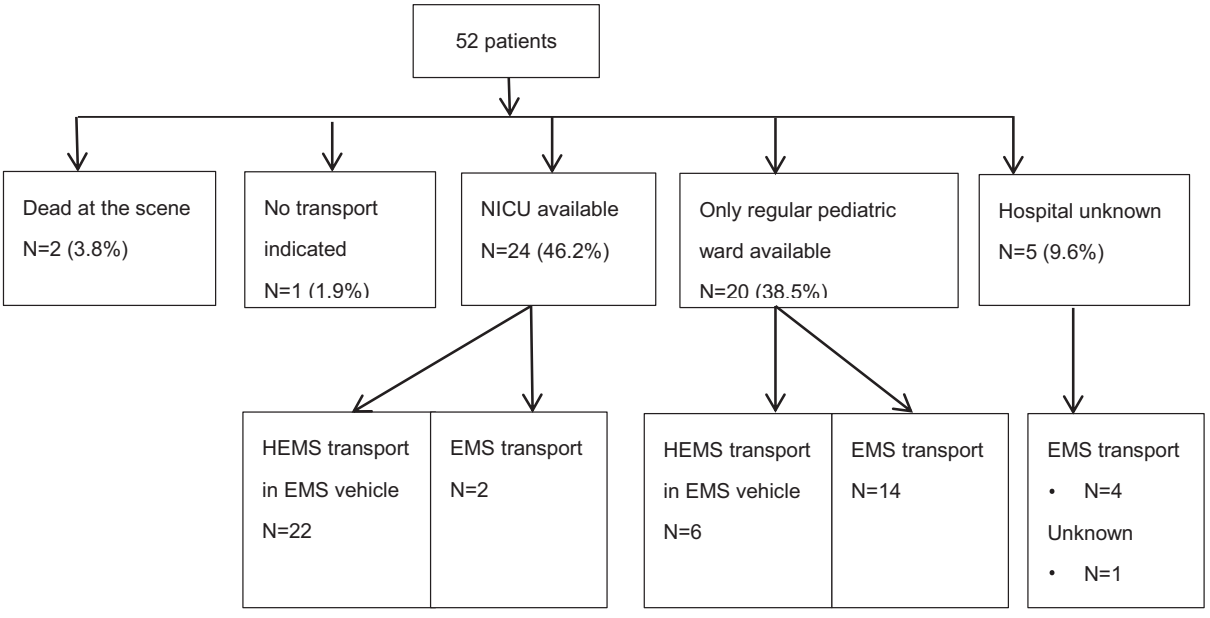

Figure 2. Transport and hospital of first admission.

During the study period, 2 pregnant women were in cardiopulmonary arrest. This is a specific group, and emergency resuscitative hysterotomy is the only chance for mother and child.[18-20] Considering the low incidence, performing a resuscitative hysterotomy is restricted to HEMS in our country.

In this cohort, we found that the first responders (midwives, EMS, and HEMS) appeared to implement BLS and advanced life support algorithms appropriately based on the clinical judgment by the HEMS physician. However, possibly because of specific training and specialized equipment for neonatal emergencies, this is based on retrospective data in a small cohort.

In several other countries, the incidence of home births is much lower[2-4,7,8,10] but has been rising again over the last couple of years in, for example, the United States.[12] To ensure that planned or unplanned home deliveries are as safe as possible, there needs to be clear guidelines as to which women can deliver at home and who should guide them and when further assistance is necessary.

Although the number of home deliveries in our country is high, the exposure for first responders to neonatal life support is very low. Therefore, all personnel present at a childbirth and first medical responders should regularly update their training and equipment to at least perform basic neonatal life support for the premature and full-term infant.

Strengths and Limitations

To our knowledge, this is the first study addressing neonatal emergencies by HEMS; we found a small cohort of 52 neonates during this 6-year period. Because the HEMS physician did not always register the full name or only the mother's surname, we could not obtain GBA data for 13 infants. We did not include EMS data because they have registered dispatches for infants < 30 days of age without further specification. These dispatches accounted for 0.5% of EMS dispatches in 2016.[21] Furthermore, we have no information about neonates transported from a prehospital situation without HEMS to a NICU, emergency department, or pediatric ward. This is because of the wide variety of hospitals and locations within the hospital in the Netherlands and Belgium where these patients could have been transported from the dispatch region.

Conclusions

The absolute number of deliveries that require additional medical care besides the midwife in the prehospital setting appears to be very low. The Netherlands has always had a high incidence of home births compared with surrounding countries. The prehospital care has adapted to this situation (eg, by training all midwives in BLS, training of newborn life support for EMS, and, if necessary, deployment of HEMS). However the absolute number of neonatal emergencies remains low for both EMS and HEMS, so continuous training remains vital to provide an adequate level of care.

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