Implementation and effectiveness of a video-based debriefing program for neonatal resuscitation

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Abstract

Background: Approximately 5-10% of newly born babies need intervention to assist transition from intra- to extrauterine life. All providers in the delivery ward are trained in neonatal resuscitation, but without clinical experience or exposure, training competency is transient with a decline in skills within a few months. The aim of this study was to evaluate whether neonatal resuscitations skills and team performance would improve after implementation of video-assisted, performance-focused debriefings.

Methods: We installed motion-activated video cameras in every resuscitation bay capturing consecutive compromised neonates. The videos were used in debriefings led by two experienced facilitators, focusing on guideline adherence and non-technical skills. A modification of Neonatal Resuscitation Performance Evaluation (NRPE) was used to score team performance and procedural skills during a 7 month study period (2.5, 2.5 and 2 months pre-, peri- and post-implementation) (median score with 95% confidence interval).

Results: We compared 74 resuscitation events pre-implementation to 45 events post-implementation. NRPE-score improved from 77% (75, 81) to 89% (86, 93), $p<0.001$. Specifically, the sub-categories “group function/communication”, “preparation and initial steps”, and “positive pressure ventilation” improved ($p<0.005$). Adequate positive pressure ventilation improved from 43% to 64% ($p=0.03$), and pauses during initial ventilation decreased from 20% to 0% ($p=0.02$). Proportion of infants with heart rate >100 bpm at 2 minutes improved from 71% pre- vs. 82% ($p=0.22$) post-implementation.

Conclusion: Implementation of video-assisted, performance-focused debriefings improved adherence to best practice guidelines for neonatal resuscitation skill and team performance.

Introduction

Approximately 5-10% of newly born babies need assistance to transition from intra- to extrauterine life and the immediate recognition and effective initiation of resuscitation measures are essential to avoid unnecessary morbidity and mortality.[1-3] Although neonatal mortality has been significantly reduced during the last two decades, there is still estimated to be 690,000 deaths worldwide every year caused by intrapartum-related events.[4] Up to 30% of these deaths may be preventable by implementing high quality training in neonatal resuscitation.[5]

Current guidelines for resuscitation education and implementation recommend the use of data-driven, performance-focused debriefings to ensure implementation of best practice.[6,7] Debriefing, defined as learning through reflection on an experience through a facilitated conversation, has been shown to be an effective tool in simulation training.[8] It has also been used in interventional bundles to improve quality of care during neonatal resuscitation.[9-12] Two studies have demonstrated improved outcomes after implementation of debriefing programs for in-hospital cardiac arrest,[13,14] but optimal format of the debriefing is unknown.

The objective of this study was to evaluate whether video-assisted, performance-focused debriefings following real neonatal resuscitations improve adherence of treatment guidelines and improve technical and non-technical skills in real neonatal resuscitations.

Methods

Ethical considerations

This prospective, educational interventional study was reviewed and approved by the Institutional Review Board (IRB) of the Oslo University Hospital. It was deemed to be quality assurance with minimal additional risk and approved presumed consent from parents. All mothers planning to give birth at the hospital received information about the study and how to register to opt-out by mail. An open webpage provided additional information about the study. Information about the study and how to opt out was also made available to all providers through staff meetings and email messages in advance. Healthcare providers and parents could withdraw their consent at any time resulting in prompt deletion of videos and any registered information. The videos were not accessible to anyone outside the research group and deleted after review and debriefing. Our IRB only allowed the providers engaged in the particular resuscitation to attend the video debriefings. This study covers the initial phase of a multi-faceted quality improvement study registered at clinicaltrials.org (NCT02347241). Implementation of debriefings was evaluated separately, and provided the basis for later interventions. The institutional approval reference number is 2013/12769 and dated 6th of September 2013.

Setting and participants

This study was performed in 2014 in the delivery unit at a Norwegian teaching hospital with approximately 600 deliveries per month. We evaluated skill performance and process of care of neonatal resuscitations using video analysis before, during and after introduction of video-assisted, performance-focused debriefings. The intervention was aimed at midwives and physicians involved in resuscitation of compromised infants. The study was divided in three consecutive time periods over seven months: 1) baseline recording of performance and skills (15th of January to 2th of April); 2) intervention period with introduction of weekly debriefings (3rd of April to 23th of June); and 3) post-implementation period with monthly debriefings (24th of June to 24th of August). We compared the three time periods using a validated scoring system to evaluate adherence to guidelines including technical and non-technical skills.[15-17] We also evaluated other factors that could have impacted performance. We included and assessed all consecutive resuscitation events where positive pressure ventilation (PPV) was provided immediately post-delivery. PPV-events that were not filmed due to technical difficulties or reservations from parent/providers were excluded.

Data collection

All resuscitation cribs were fitted with motion-activated video cameras (Hikvision 2-megapixel IP-camera, Hangzhou, China) which started recording automatically when any motion occurred capturing the infant, the providers' hands, and audio. The video setup has been described previously.[18] To ensure consistency, the same investigator (C.S.), not blinded to the study phase, analysed all videos. A random selection of 52 videos was scored twice by this same investigator to check intra-rater reliability. Another investigator (E.S.), blinded to the study phase, scored another random 26 videos to check interrater reliability. Time intervals measured in seconds are from arrival to the resuscitation crib. Pulse oximetry data (Masimo Radical, Masimo Corporation, CA, USA) was collected and analysed using appropriate software (ixTrend, GmbH ixellence, Wildau, Germany). We searched infants' medical records for supplementary information.

Description of the scoring system

We used a modified Neonatal Resuscitation Performance Evaluation (NRPE) tool originally developed for simulation training,[16,17] and modified and validated for use in clinical practice.[19] We adjusted it to Norwegian guidelines by modifying assessment of oxygen use and adding “Calling for help”. The NRPE provides scores for nine areas including team function, initial steps of resuscitation, assessment/communication of heart rate, administration of oxygen, non-invasive and invasive ventilation, administration of chest compressions and medicines (Table 3). Area 1-5 could be scored in all PPV-events, and area 6-9 could only be scored if advanced resuscitation measures were provided. The performance of each resuscitation measure was evaluated for technique, success, and proper re-evaluation of response. Each of these steps were scored with zero point if poorly performed or omitted, one point if performed late or sub- optimally and two points when performed adequately. Percentages of maximal score for each area and the sum score comprise the results. The scoring was based on the performance of the whole team.

Video-assisted, performance-focused debriefings

All videos were reviewed and scored, and videos with sufficient length (more than a few minutes) and quality were selected for debriefing with the staff that had attended the resuscitation. Two experienced facilitators, also working as consultants in neonatology (T.E.C. or T.R.) and anaesthesiology (C.S.) with formal background from medical simulation, led all debriefings. The sessions started with introduction of the learning objectives consisting of both non-technical and technical skills. The facilitators guided the participants through the

3 phases of the debriefing, (as described below) facilitated discussion of relevant topics and learning objectives while encouraging the participants to discuss and reflect using open-ended questions and active listening to enhance the dialogue. Focus was on team behaviour, leadership, communication, task management, PPV-skills and adherence to neonatal resuscitation guidelines.[20]

The debriefings consisted of 3 phases; descriptive, analytic, and reflective phase. First, uninterrupted watching the videos helped providers recall the incidence and briefly describe it. The analytic phase commenced by showing short sequences of the video and asking providers to find examples of good performance or behaviour. The providers then identified areas of improvement. Finally, in the reflective phase, providers summarized learning points and future application of knowledge. Examples of questions asked during the different phases are found in Table 1. The debriefings lasted approximately 45 minutes. We aimed to include all team members (physicians, midwives, nurses) in the debriefing, but due to different shifts, they were not always available at the same time. We arranged debriefings when two or more providers were available, as soon as possible after the event.

Data analysis

A sample size estimate showed that to detect a meaningful increase in percent NRPE-score from 70 to 80% pre-intervention compared to post-intervention with power of 80%, two-tailed alpha of 5% and standard deviation of 15%, a sample size of 47 in each group was needed. In similar studies, improvements of 10% have been considered clinically meaningful.[17,21] With an incident of PPV of 4%,[1] and approximately 600 deliveries per month at our hospital, the pre- and post-intervention period was estimated to be 2 months. We report performance data of all consecutive PPV-events for all three study phases to capture and describe the entire implementation process, but only pre- and post-implementation phases were formally compared as they were expected to best reflect the steady-state effect of the intervention.

Statistical calculations were performed using SPSS 22.0 (SPSS Inc., IL, USA). As most values were not normally distributed, values are given as numbers with percentages or medians with 95% confidence intervals (95% CI). Categorical outcome data were analysed using Pearson Chi-Square test. Continuous data were compared with independent samples Mann-Whitney U test for two groups or Kruskal Wallis test for three groups. Two-sided p-values ≤ 0.05 were considered significant. Intra- and inter-rater agreement for the percent NRPE-score both for the total and the 5 main areas were scored by reliability statistics with "Intraclass Correlation Coefficient (ICC)" using a two-way mixed, single-measure model to assess the absolute agreement in their ratings.

Results

Of the 4578 infants born at the hospital during the 7-month study period, 209 (5%) received PPV and 188 (4%) were included for further analysis. The cohort with reasons for exclusions is presented in Figure 1. We scored and compared video-recordings from 74, 69 and 45 resuscitation events during the pre-, peri- and post-intervention periods, respectively. During the intervention period we arranged 16 debriefings with 35 unique attendees (16 midwives, 4 nurses, and 15 physicians), 6 attended more than one session. Due to variations in staff placement, task allocation and shift distribution, it was not possible to calculate the accurate proportions of providers at risk for participating in a resuscitation and thus in the target group for debriefing. The only group of providers that is always paged when resuscitation is needed is paediatric residents, and in this group 7 of 9 (78%) attended at least one debriefing. After this high-intensity run-in period, we had monthly debriefings. The implementation of the debriefings is described in Figure 2. The median time period between the actual resuscitation and the debriefing was 11 (8, 24) days. The distribution of infant characteristics, resuscitation measures and clinical outcomes were similar before and after the debrief-intervention (Table 2).

Ventilation quality

The PPV-quality improved throughout the study with 32/74 (43%) infants pre- vs. 29/45 (64%) infants post-intervention receiving adequate PPV, defined as visible chest rise or clinical improvement of the infant, prior to spontaneous respiration (p=0.03). We observed significant fewer pauses in PPV during the first 30 seconds of resuscitation (20% (10, 30) vs. 0% (0, 13), p=0.02) and shorter time to PPV (45 (34, 56) vs. 34 (26, 50) seconds p=0.23) in the pre- vs. post-intervention periods, respectively. Duration of PPV was 129 (87, 193) seconds vs. 107 (71, 127) seconds (p=0.57), time to heart rate >100 bpm was 72 (41, 90) seconds vs. 70 (32, 87) seconds, (p=0.78) and proportions of infants with heart rate >100 bpm after 2 minutes were 71% vs. 82%, (p=0.22) in the pre- and post-intervention periods, respectively.

Adherence to guidelines

The median total NRPE-score increased from 77% (75, 81) to 89% (86, 93) from the pre- to post-implementation period (p<0.001), and we found improvements in the following categories: “group function/communication” (p=0.001), “preparation and initial steps” (p<0.001), ”PPV” (p<0.001) and “administration of oxygen” (p=0.08) . The NRPE-scores are presented in Table 3. Intra-rater and inter-rater reliability of the NRPE-score were median ICC 0.91 (0.85, 0.95) and 0.76 (0.53, 0.88) for total score, and median ICC 0.74 (0.59, 0.81) and 0.61 (0.22, 0.76), respectively for the five main categories.

Other factors impacting guideline compliance

The NRPE-score was significant higher when a paediatrician (either senior or resident) was present from the beginning of the resuscitation event compared to the resuscitations initiated without a paediatrician; 80% (76, 82) vs. 64% (48, 76) pre-intervention and 94% (89, 97) vs. 83% (71, 91) post-implementation, p=0.002. The resuscitation was initiated without a paediatrician in 23 (31%) events during baseline and in 21 (47%) events post-intervention. In events where a paediatrician was not present from the beginning of the resuscitation, they arrived within median 118 (116, 202) vs. 83 (57, 171) seconds pre- and post-intervention, respectively.

Discussion

This study has examined the effectiveness of an educational intervention aimed at improving compliance with neonatal resuscitation guidelines for front-line neonatal staff. The results of this study demonstrate improved adherence to the initial steps of resuscitation algorithm as well as improved performance in both technical and non-technical skills after implementation of video-assisted, performance-focused debriefings. We observed the greatest improvement in technical skills such as ensuring an open airway and performing adequate PPV and non-technical skills such as improved group function and communication.

Debriefing has been identified as one of the most important components of healthcare simulation, but the literature of its role after real-life neonatal resuscitation is scarce. The simple experience of attending a neonatal resuscitation does not lead to improved practice, yet the use of facilitated debriefings can maximise the opportunity for learning.[8,22,23] Our study indicates that debriefing is a valid method for enhanced learning after real-life neonatal resuscitations. Nadler et al. found that video-assisted debriefings focusing on teamwork had positive effects on teamwork during neonatal resuscitation, but less effect on non-teamwork items.[9] Our study differs from this study as our debriefings included technical issues as well as team performance, were less frequent and only available to those that had actually attended the resuscitation. Even with fewer debriefings compared to this study and less resources to conduct the debriefings, we showed improvement in both technical and non-technical skills.

Methods of debriefing have been adapted from the aviation industry, military service and psychology,[8,24] but the best method to ensure optimal learning from debriefing has yet to be established.[25] Several principles are widely accepted, such as assuring a safe environment and encouraging providers to reflect and learn from their actions.[8] In the resuscitation literature, objective data such as feedback from the defibrillator,[13] trained observers or video recordings[9,26] have been suggested to facilitate post-event debriefings. In simulated settings, video-assisted debriefings are not superior to debriefings without videos,[27] but these differ from clinical debriefings since they may be held immediately after the simulation episode. We used video recordings as the basis for discussion and reflection in supplement to the providers own memory, and found videos to be a good tool to aid recollection of the resuscitation events and help the facilitator guide the providers through the debriefing. It was useful for the providers to get objective feedback on actual performance, and they often reflected on their own behaviour and found areas for improvement without any comments from the facilitator. Our findings were supportive of a study of trauma resuscitation that found video review to be more effective than verbal feedback alone.[28]

Reflective practise may improve standard of care,[29] and routine video-recording and post-event debriefing may be an area for practising reflection and helping the providers to integrate insights from experiences into future practise.[30] We also used elements from After Action Review (AAR), aiming to maximize learning from the event. Similar to AAR, we encouraged active participation of the whole team in an open professional discussion around the event with focus on “What actually happened?” “What went well and why?” “What can be improved and how?” and “What have we learnt?”[31]

We aimed to improve neonatal resuscitation quality for both the expected and unexpected compromised neonates by offer debriefing to all the relevant providers. All providers participating in the selected resuscitation event were therefore invited to the debriefings. Unlike other studies of debriefings after cardiac arrest which allowed all providers in the department to participate to maximize the educational value from each resuscitation,[13,14] our IRB restricted access to the video debriefings to only the providers participating in the event. While our strategy and the requirement of the IRB approval resulted in fewer providers per debriefing, we experienced several benefits to this approach: The small groups made a safe environment where roles and performances of all the providers could be reviewed, analysed and discussed. The debriefings were relevant to the providers as learning points directly reflected their own action. The importance of relevance to the providers is regarded as one of the main factors for success emphasized in adult learning theory.[8]

We adopted a pragmatic approach in debriefing selected cases we believed had the highest educational value, rather than debrief all resuscitations as recommended in current resuscitation guidelines.[7] Debriefings are resource demanding, and the cost needs to balance the gain within the participating department. Full debriefings of all resuscitations were not feasible in our institution. Shorter team-huddles immediately after the events could have allowed for more resuscitations being "debriefed", and could perhaps be a useful addition.

Despite observed improvements in skills, we were unable to demonstrate any significant improvements in outcome measures such as time to heart rate >100 bpm. Initial heart rate is notoriously elusive in neonatal resuscitation research. There are significant delays in monitors using SpO_2 to detect heart rate values, palpation of heart rate has been shown to be less reliable,[32] and while standard ECG leads are more accurate,[6,32] they are not commonly used, thus leaving few robust data sources for accurate determination of heart rate. As an increase in heart rate is the best physiologic indicator of effective PPV,[6] there is a clear need for better tools to reliably detect and record initial heart rates during neonatal resuscitation.

There are several limitations to this study. First, it is designed as a before- and after study. A randomized controlled trial design was not deemed feasible in this single institution study as an intervention group was very likely to influence any control group. Second, the improvements observed may partly be due to an increasing “Hawthorne effect” as providers might become increasingly aware they were being observed after initiation of debriefings.[33] However, some of these effects may have been mitigated by using video cameras which were unobtrusive and without noticeable sounds or lights. Third, it was not possible to blind the video reviewer to the study phase since we had to delete the videos immediately after review. Fourth, the study was not designed to evaluate whether monthly debriefings are sufficient to maintain the improved performance. However, it seems reasonable that seeing one’s own performance on video followed by structured reflection and discussion might have longer retention compared to traditional classroom training. The optimal duration, frequency and interval between event and debriefing should be focus for future research. Finally, the study was not powered to detect changes in the most clinically relevant outcomes such as neurological impairment and death, therefore, improvements in process of care may not directly translate into improved patient outcomes.

Conclusion

Compliance with best practice guidelines for neonatal resuscitation improved after implementation of video-assisted, performance-focused debriefings. Improvements were observed in the areas of team performance, initial preparation and ventilation skills.

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Conflict of interest statement: None

Legends to figures:

Figure 1. Description of the study cohort.

Figure 2. Overview of the three study periods with implementation of video-assisted performance-focused debriefings.

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Fig. 1

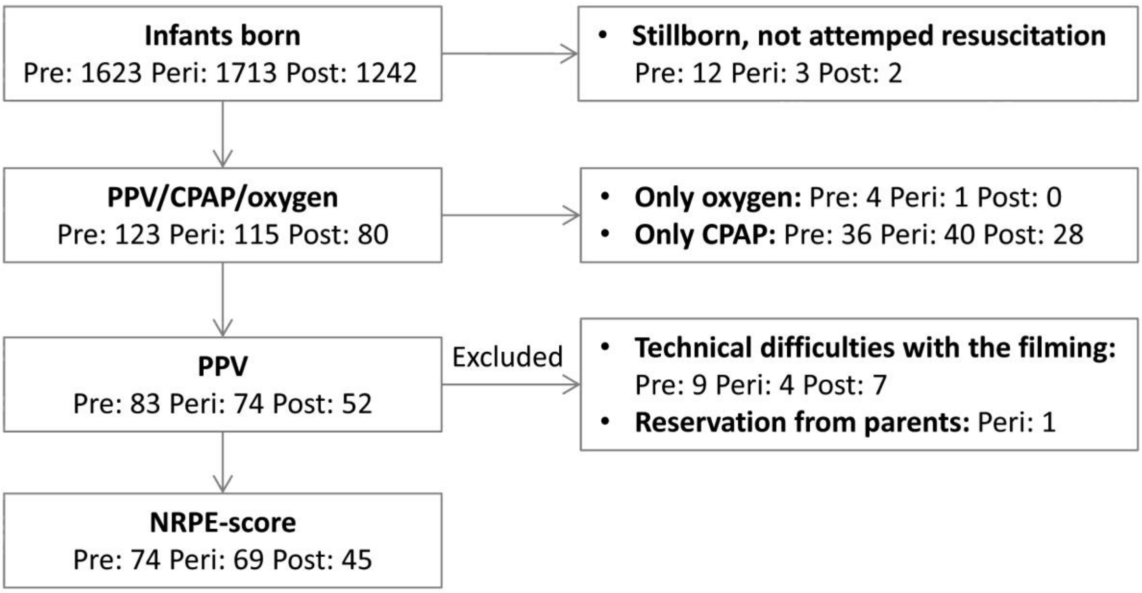
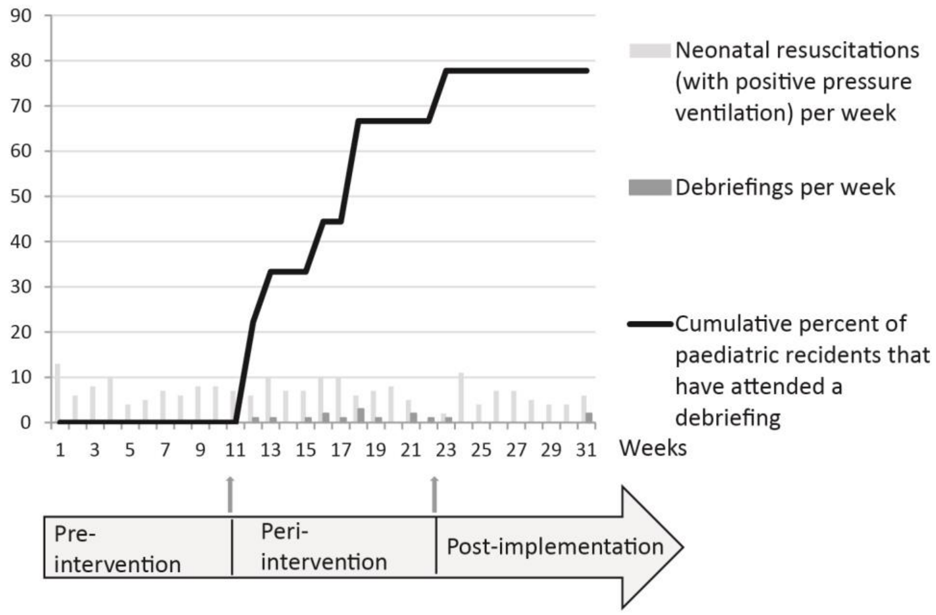


Fig. 2



90
80
70
60
50
40
30
20
10
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31
Weeks
Neonatal resuscitations (with positive pressure ventilation) per week
Debriefings per week
Cumulative percent of paediatric recidents that have attended a debriefing
Pre-intervention
Peri-intervention
Post-implementation

Table 1 Typical questions asked at the performance-focused debriefings.

Descriptive phase
• Can you describe the case? • What happened? • What were the main issues you had to deal with? • Which measures did you take?
Analytic phase
• What went well? Why? • What was your plan? • What were your assessments? • How was team performance? Examples of good performance? • How was communication? • Describe the workload management? • How was your experience as a team member/leader? • Any problems? Why? • What could have been done differently? Why? • What could have made the situation easier? Why?
Reflective phase
• Did you learn anything from reviewing this case? • Which aspects of resuscitation do you need to practice more? • What can you do better next time? • How do you think this discussion may influence your future behavior?

Table 2 Characteristics, resuscitation measures and outcome in infants receiving positive pressure ventilation (PPV) and included in further analysis.

Study-period	Pre-intervention N=74	Peri-intervention N=69	Post-implementation N=45	p
Gestational age	39 (38, 40)	40 (39, 40)*	40 (38, 41)	0.44
Weight (g)	3089 (2800, 3340)	3344 (3070, 3490)*	3222 (2636, 3590)	0.43
Male	39 (53%)	35 (51%)*	23 (51%)	0.49
Apgar 1 min	5 (5, 6)	5 (4, 6)*	5 (3, 6)	0.24
Apgar 5 min	7 (6, 8)	8 (7,8)*	8 (7, 8)	0.24
Apgar 10 min	9 (8, 9)	9 (9, 9)*	9 (8, 9)	0.85
CPAP	52 (70%)	45 (65%)	33 (73%)	0.72
Endotracheal intubation	7 (10%)	6 (9%)	6 (13%)	0.51
Chest compressions	3 (4%)	3 (4%)	2 (4%)	0.92
NICU at 1 h	41 (56%)*	38 (55%)	22 (49%)	0.49
NICU at 24 h	37 (51%)*	24 (35%)	17 (38%)*	0.19
Hypothermia	2 (3%)	1 (1%)	0 (0%)	0.27

NICU=Newborn Intensive Care Unit. *One missing value. Data are given as median (95% confidence interval) or number (%). P-values are given for the difference from the pre-intervention to the post-implementation period. Comparisons of continuous data were done with independent samples Mann-Whitney U test and categorical data were analyzed using Pearson Chi-Square.

Table 3 Modified Neonatal Resuscitation Performance Evaluation (NRPE) score.

Study-period Total score in each main area and numbers of resuscitations (%) with correct performance in the subareas.	Pre-intervention n=74	Peri-intervention n=69	Post-implementation n=45	P 1 vs. 3
Total NRPE score (% of max. possible score)	77 (75, 81)	81 (74, 84)	89 (86, 93)	<0.001
1) Group function/communication; Total (%),	88 (75, 90)	83 (75, 92)	100 (92, 100)	0.001
a) Clearly defined and functioning leader	58/74 (78%)	47/69 (68%)	30/45 (67%)	0.16
b) Minimal overlap of individual team member functions	40/74 (54%)	46/69 (67%)	39/45 (87%)	<0.001
c) Evidence of team collaboration/cooperation	54/74 (73%)	43/69 (62%)	41/45 (91%)	0.02
d) Evidence of communication	49/74 (66%)	41/69 (59%)	39/45 (87%)	0.014
e) Integration of processes (equipment ready during procedures)	25/58 (43%)	29/54 (54%)	34/40 (85%)	<0.001
f) Calling for help if needed	27/33 (82%)	52/53 (98%)	39/41 (95%)	0.07
2) Preparation and initial steps; Total (%),	75 (70, 80)	80 (75, 88)	90 (80, 100)	<0.001
a) Checking of equipment	37/56 (66%)	45/56 (80%)	31/43 (72%)	0.52
b) Temperature control (placed correctly on warmer, drying, plastic wrapping when needed, remove towel)	59/74 (80%)	62/69 (90%)	45/45 (100%)	0.001
c) Position with neck in right position	44/74 (59%)	53/69 (77%)	37/45 (82%)	0.010
d) Tactile stimulation (0 p if continued on an apnoeic infant, or omitted from an initially depressed infant)	36/66 (55%)	42/67 (63%)	39/45 (87%)	<0.001
e) Suctioned mouth/nose (if secretion obstructing the airways or meconium and inadequate respiration)	16/43 (37%)	5/36 (14%)	11/25 (44%)	0.58
3) Communication of heart rate (HR); Total (%),	63 (50, 75)	75 (50, 75)	75 (50, 100)	0.42
a) HR checked by stethoscope before 60 sec.	49/74 (66%)	42/69 (61%)	29/45 (64%)	0.84

b) HR communicated to the team (tapped out with finger, verbally communicated)	34/74 (46%)	30/68 (44%)	26/45 (58%)	0.21
4) Administration of oxygen; Total (%),	100 (100,100)	100 (100, 100)	100 (100, 100)	0.08
a) Start ventilation with room air	71/72 (99%)	67/69 (97%)	44/45 (98%)	0.74
b) Increasing FiO_2 after response	41/49 (84%)	47/52 (90%)	24/25 (96%)	0.13
5) Positive pressure ventilation; Total (%),	70 (67, 75)	80 (70, 90)	100 (80, 100)	<0.001
a) Appropriate decision based on clinical condition of infant (apnoeic/gasping, HR<100)	65/74 (88%)	54/69 (78%)	36/45 (80%)	0.25
b) Technique: Correct mask size chosen	61/74 (82%)	61/68 (90%)	45/45 (100%)	0.003
c) Correct rate (30-60 per minute=2 p)	39/69 (57%)	40/69 (58%)	35/45 (78%)	0.02
d) Correct pressure and seal (adequate chest rise)	19/74 (26%)	27/65 (42%)	26/44 (59%)	<0.001
e) Re-evaluation for response (HR after 30-60 sec)	58/74 (78%)	61/69 (88%)	38/45 (84%)	0.42
6) Endotracheal intubation;	n=7	n=6	n=7	
Total score (%)	67 (42, 92)	75 (8, 92)	92 (83, 92)	
7) Chest compressions,	n=3	n=3	n=1	
Total score (%)	43 (42, 86)	71 (43, 100)	64	
8) Administration of medicines;	n=8	n=4	n=4	
Total score (%)	100 (50, 100)	100 (83, 100)	100 (100, 100)	
9) Intravenous access;	n=4	n=3	n=0	
Total score (%)	94 (50, 100)	100 (100, 100)		

Total score in each main area and numbers of resuscitations (%) with correct performance in the subareas. Total scores are reported as a percent of the maximum possible score in each case (sum score/max. score). The percent are given in median (95 % confidence interval). Comparisons of continuous data were done with independent samples Mann-Whitney U test and categorical data were analysed using Pearson Chi-Square. In each subcategory we report the numbers (% of applicable cases) with correct performance (2 points).