Video assessment of health worker performance in neonatal resuscitation in four district hospitals in Pemba, Tanzania: A prospective cohort study.

Charlotte Holm-Hansen[1], Stine Lund[2], Tine Skytte[2], Jil Molenaar[1], Christina Steensgaard[2], Ulfat Mohd[3], Said Mzee[3], Said Ali[4], Jesper Kjaergaard[1], Gorm Greisen[1], Jette Sorensen[5], and Anja Poulsen[1]

[1]Rigshospitalet
[2]Affiliation not available
[3]Public health laboratory
[4]Public Health Laboratory-IDC
[5]Copenhagen University Hospital Rigshospitalet

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Abstract

Abstract Objective To assess the quality of neonatal resuscitation (NR) through video recordings and identify potential areas for improvement. Design Prospective cohort study. Setting From September to December 2019, at four district hospitals in Pemba, Tanzania. Population All labouring women and their newborns were eligible for participation. Main Outcome Measures Videos were analysed for quality-of-care indicators based on the NR algorithm. Questionnaires on quality-of-care indicators were answered by health workers (HW) and mothers. Risk factors for neonatal mortality were analysed in a binomial logistic regression model. Results A total of 1440 newborns were enrolled. Within the neonatal period, 34 newborns died (23.6 per 1000 live births). During the study period, 90 neonatal resuscitations were performed, of which 20 were recorded. Meantime to initiate positive pressure ventilation (PPV) with bag-and-mask was 98 seconds (10 – 416 s), it was inadequately performed in 15 cases (75%). Half (10/20) did not have PPV initiated within the first minute, and in 1 case (5.0%) no PPV was performed. PPV was initiated but not sustained in 16/20 (80%) newborns. Of the 20 infants with videos, 10 died: Eight after failed resuscitation and two in the first 24 hours. The majority of HW 49/56 (87.5%) had received training in NR. Conclusions Despite nearly 90% of HW being trained in NR, video analysis revealed significant deviations from guidelines, provided direct evidence of gaps in the quality of care and identified areas for future education, particularly effective bag- and mask ventilation. Keywords PERINATAL NEONATAL MORTALITY RESUSCITATION VIDEO RECORDIN

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Charlotte Carina Holm-Hansen[1], Stine Lund[1,2,] Tine Bruhn Skytte[1], Jil Molenaar[1,3], Christina Nadia Steensgaard[1], Ulfat Amour Mohd[4], Said Mzee[4], Said Mouhammed Ali[4], Jesper Kjærgaard[1], Gorm Greisen[2,5], Jette Led Sorensen[5,6], Anja Poulsen[1]

[1] Global Health Unit, Department of Paediatrics and Adolescent Medicine, The Juliane Marie Centre Copenhagen University Hospital, Rigshospitalet, Copenhagen, Denmark

[2]Department of Neonatology, The Juliane Marie Centre for Children, Copenhagen University Hospital Rigshospitalet, Denmark

[3]Centre for Migration and Intercultural Studies (CeMIS), University of Antwerp, Belgium

[4]Public Health Laboratory – Ivo de Carneri, Chake Chake, Pemba, Tanzania

[5] Department of Clinical Medicine, Faculty of Health and Medicine Sciences, Copenhagen University, Denmark

[6]The Juliane Marie Centre for Children, Women and Reproduction, Copenhagen University Hospital Rigshospitalet, Denmark

*Corresponding author: Charlotte Carina Holm-Hansen

Charlotte.carina.holm-hansen@regionh.dk

Global Health Unit, 4072

University Hospital Copenhagen

Blegdamsvej 9, 2100 Copenhagen Denmark

+45 23 96 73 25

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All labouring women and their newborns were eligible for participation.

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Videos were analysed for quality-of-care indicators based on the NR algorithm. Questionnaires on quality-of-care indicators were answered by health workers (HW) and mothers. Risk factors for neonatal mortality were analysed in a binomial logistic regression model.

Results

A total of 1440 newborns were enrolled. Within the neonatal period, 34 newborns died (23.6 per 1000 live births). During the study period, 90 neonatal resuscitations were performed, of which 20 were recorded. Mean time to initiate positive pressure ventilation (PPV) with bag-and-mask was 98 seconds (10 – 416 s), it was inadequately performed in 15 cases (75%). Half (10/20) did not have PPV initiated within the first minute, and in 1 case (5.0%) no PPV was performed. PPV was initiated but not sustained in 16/20 (80%) newborns. Of the 20 infants with videos, 10 died: Eight after failed resuscitation and two in the first 24 hours. The majority of HW 49/56 (87.5%) had received training in NR.**Conclusions**

Despite nearly 90% of HW being trained in NR, video analysis revealed significant deviations from guidelines, provided direct evidence of gaps in the quality of care and identified areas for future education, particularly effective bag- and mask ventilation.

Keywords

PERINATAL NEONATAL MORTALITY RESUSCITATION VIDEO RECORDING

Introduction

Approximately 2.5 million newborns die in the neonatal period, and most of these deaths are preventable by effective interventions delivered during the whole continuum of care during antenatal, intrapartum, childbirth and post-natal care. [1 2] Additionally, 2.6 million stillbirths occur annually, half of these intrapartum.[3-6] Most of the mortality occurs in low and middle-income countries (LMIC). [7 84] The 2030 Sustainable Development Goals (SDG 3.2) sets a target of less than 12 neonatal deaths per 1000 live births. However, current global projections are not on track to attain the 2030 SDG target. [7 9 10]

Neonatal mortality is greatest in the first 24 hours of life, where approximately 36% of mortalities occur. [3 5] An estimated 73% of neonatal deaths occur within the first week of life.[3 5] The leading causes of neonatal death are intrapartum-related events (previously birth asphyxia), infections, and preterm birth complications. [3 7 11 12] What happens immediately after birth can affect an entire life course. [13 14] Positive pressure ventilation (PPV) is the key component of neonatal resuscitation, as 10% of newborns fail to initiate and sustain adequate breathing at birth.[15-20] Neonatal resuscitation programmes (NRP) such as Helping Babies Breathe (HBB) can reduce intrapartum-related stillbirths and early neonatal mortality but focus on the whole continuum of reproductive, maternal, and newborn care is needed to increase overall neonatal survival. [14 21-23]

The quality of NR in LMIC and translation of knowledge into clinical practice remains a challenge. [13 14 20] Video recording has been used to evaluate health workers (HW) neonatal resuscitation (NR) performance and adherence to guidelines, primarily in high-resource settings, with a few recent studies from tertiary hospitals in LMIC.[20 24-32] Our feasibility study supported that video can be used to understand gaps in quality of care in NR in this context.[33]

This study aimed to assess the quality of neonatal resuscitation in four secondary health facilities in Pemba, Zanzibar, through video recordings and identify potential areas for improvement

Methods

Study design

The study was a prospective cohort study, and part of a pre-post intervention trial, the Newborn Emergency Outcome Study, with the aim of reducing neonatal mortality (clinicaltrial.gov NCT040937778, Zanzibar Health Research Institute: NO.ZAHREC/2 August 2019/30). The study was conducted at four district hospitals in Pemba, Tanzania, for 11 weeks from September to November 2019. The STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) checklist was applied for the reporting of the current study.

Setting

Pemba is an island in the Zanzibar archipelago with approximately 450.000 inhabitants. [34 35] There are four district hospitals assisting a total of 11.000 births each year.[35] The facility rate for births is increasing, with 67.6% of all births taking place in health facilities in 2019.[35] Human resources are scarce, and only a few medical doctors or clinical officers are available at each hospital. The nurse/midwife-to-labouring women ratio is between 1:2 and 1:4, depending on the time of the day. All hospitals have access to instrumental assisted birth and caesarean section. The NR guidelines available in facilities are an HBB poster and guidelines provided by the Ministry of Health and WHO. [18] The available equipment for the management of the newborn consists of a resuscitation table in three out of four hospitals, gloves, bulb suction, a self-inflating

bag and mask, and an oxygen source (not always available). Traditional clothes, called a kanga, brought by the women in labour are available for wrapping, drying, and preventing heat loss of the newborn.

Participants

Women in labour and their newborns, both singleton and multiple gestations were eligible for participation. All stillbirths were excluded and reported in a separate study. [36]Participants were enrolled once their hospital admission completed and consented to video recording of the newborn immediate care and evaluation. Consent was confirmed post-partum. If prospective consent was not possible, participants were enrolled after giving consent, as soon as possible after childbirth. All HW at the four maternity wards consented to participate, and no economic incentives were provided.

Data sources, data collection and management

A motion-triggered camera was used and recorded all instances of newborns being placed on the resuscitation table. We tested the acceptability of video recordings of NR in a feasibility study.[33]

We recruited 18 research assistants with healthcare backgrounds. A postnatal questionnaire was performed and collected sociodemographic, obstetric, birth and neonatal data. Data was stored into RedCap (v5.12.1). The HW in charge of the specific birth filled out the sections specific to obstetric risk factors and the birth outcome based on WHO and national guidelines. [1817] Efforts were made to follow up with all study participants by phone when the newborn turned 28 days. A village follow-up was planned but had to be cancelled in March 2020 due to the Covid-19 pandemic.

Outcomes and Variables

Resuscitation of newborns with PPV captured on video were included in the analysis. We used a previously published analytical framework of quality-of-care indicators where resuscitation procedures are scored according to guidelines. [18 33] The clinical appearance of the newborn was logged as no respiration=0, gasping=1 or breathing=2. The clinical actions performed by the HW were registered in a thematic template, including a description of performance on heat loss prevention, positioning of the newborn's head, clearing the airway via suction, stimulation, bag and mask ventilation, heart rate assessment and oxygen management. Each intervention was assessed at three levels: properly performed procedures, inadequate performed procedures (delayed intervention or inadequate technique for a given procedure), and procedures omitted or performed but not indicated according to NR guidelines. [18 33]

Data analysis

All video recordings were analysed by CH. Two independent researchers (CS and SL) randomly selected one-quarter of the videos for quality assessment. The videos were reviewed after the study period, and an individual timeline was produced to document procedures performed in each neonatal resuscitation.

Video observations were registered in Excel (version 16.60, Microsoft Corporation, Washington, United States), and quantitative variables were registered in RedCap. We categorised continuous variables according to common medical standards and newborn risk factors. In descriptive statistics we used numbers and percentages or median and interquartile range (IQR).

Differences in continuous variables were performed using independent-sample t-tests. Chi-square tests were used to compare variables. To investigate variables associated with pregnancy and birth outcomes, a binominal logistic regression model was used. Analysis for each confounder was adjusted for the mother's age and presented with adjusted odds ratios [AOR], including 95% CI. Birth weight was included in the logistic models for the newborn. Twin births were considered two distinct cases in the logistic regression models. Due to the limited number of twin births (n = 52), the bias for these samples was considered limited.

All tests were two-sided, and all analyses were considered significant if $p < 0.05$. Estimates were shown with 95% confidence intervals (CI). SPSS (version 28.0, IBM, New York, United States) was used for analysis.

Results

During the study period, 2183 newborns and their mothers were eligible for participation, and informed consent was obtained for 1440 liveborn newborns. Of 90 neonatal resuscitations, 20 were recorded with sufficient quality to be included in the analysis (Figure 1). Sociodemographic, education, training, and experience of the 56 participating health workers are presented in table 1.

Neonatal mortality, characteristics, and risk factors

During the study period, 34 newborns died in the neonatal period, corresponding to a neonatal mortality rate (NMR) of 23.6 per 1000 live births. Seven of the 34 neonatal mortalities were excluded due to incomplete information. The remaining 27 neonatal deaths were included in the analysis; 25 died within the first 24 hours after birth, one between day one and day seven and one between day seven and 28.

Significant risk factors for neonatal death were older maternal age, multiple gestations, previous death of a newborn, no antenatal care attendance (ANC), no foetal movement, manual rupture of membranes, breech presentation, caesarean section, male sex, low birth weight, no immediate cry after birth, APGAR score <7 at 1, 5 and 10 minutes, resuscitation attempt, PPV, suction, and administration of antibiotics to the newborn immediately after birth (Table 2 and 3).

Resuscitation videos, and adherence to guidelines

A total of 90 newborns were resuscitated, of which 20 were judged to be adequately recorded. The excluded cases were due to: 1) The camera was shielded at the time of the resuscitation due to other patients in the same room who did not provide their consent, 2) Consent was not obtained before birth due to late presentation, labour pain, or an obstetrical emergency, 3) The resuscitation was performed in another location. 4) Technical camera issues. The remaining videos were analysed for quality of care (table 4), and timelines for each resuscitation were created (figure 2).

PPV initiation was inadequately performed in 15 cases (75%). The mean time to first ventilation was 98 seconds (10 – 416 s). Timing was started when the newborn was placed on the resuscitation table. Within the first minute of life, nine patients (45%) were ventilated and 10 (50%) were not ventilated, and in 1 case (5.0%) no PPV was performed. Suction was performed vigorously and repeatedly in 16 patients (80%), and a median time of 65 seconds (12 – 177 s) was spent suctioning. In all cases, ventilation was initiated but not sustained (or not performed at all) with breaks between efforts. On average, in the first 15 minutes or until resuscitation was ceased, no intervention was performed one-third of the time.

Of the 20 resuscitation recordings, 10 (50%) died; eight after attempting resuscitation (median time spent on resuscitation: 480 seconds (95 – 3632 seconds), and two died in the subsequent hours after initially successful resuscitation.

Discussion

Main findings

To our knowledge, this is the first study to use video recording to assess NR performance in secondary-level district hospitals in a resource-constrained setting. Our study found several deviations in the quality of care on all NR indicators assessed and low adherence to NR guidelines (table 4). Particularly NR performance for ventilation, which is the most important NR intervention, was suboptimal; it was not initiated within the first minute (or at all) in 55% of the cases, unsustained (or not performed at all) with frequent interruptions in 75% of the cases. Furthermore, other tasks not indicated by NR guidelines were being performed, such as vigorous suction, or in one-third of the time, no intervention were being performed.

Interpretation

In our study, 87.5% of HW had attended at least one training in neonatal resuscitation, and 70% of the HW performed resuscitations on a regular basis. Despite this, our findings documented challenges in adherence to NR guidelines, stressing that NR programmes cannot stand alone. Transfer of competencies learned during training into clinical practice remains a key challenge. A study from Nepal using HBB with a quality

improvement cycle showed improved adherence to NR guidelines.[37] They attribute their success to a multifaceted intervention involving local leadership, multidisciplinary quality improvement teams, daily debriefings, root-cause analysis of poor NR performance and development of inclusive quality improvement goals.[37] In addition, a systematic review from 2020 of the HBB programme from its initiation in 2010 found a reasonable translation of knowledge and skills. [38] Yet, few studies have documented the transfer of knowledge into clinical practice reflected in neonatal outcomes. [38 39] A HBB review on the effect on intrapartum-related stillbirths and neonatal mortalities found mixed results on mortality reduction, which further supports that training with frequent refreshers could aid in preserving knowledge and skills.[39] Thus, there is a need to re-think traditional training and, to a greater extent, support the implementation of learned knowledge and skills into clinical practice.

Videos can help to recognise and monitor essential areas of improvement and aid intervention design. The insights from the videos could not have been obtained by any other means. Direct observations by research assistants could provide some structured observations about NR but cannot provide a real-time recording of NR for analysis and understanding of the actual challenges. Furthermore, direct observations generate a number of ethical issues where an observer should be a trained clinician in order to observe such a complex clinical situation as NR, but a trained clinician should obviously intervene in life-threatening situations. Many studies, both from high-resource settings and a few from low-resource settings, support videos to understand the quality of care. [20 24-32] Video recordings are beneficial for understanding NR, and our study from Pemba proved that video recordings are also beneficial to understand gaps in the quality of recommended essential newborn care and emphasizes the need for improved post-natal care of healthy newborns to prevent morbidity and mortality. [40 41] Similarly, a study from Nepal reports that emphasis on post-natal care is paramount to sustain gains in survival after resuscitation and NR programmes.[23]

Our findings stress the need to prioritise effective PPV since oxygenation and reduction of shunts are the key interventions to reverse hypoxia. [15] Our results are consistent with previous studies from LMIC in Nepal, Mozambique, and Uganda who found unsustained ventilation and delays in establishing ventilation. [20 26 28 31 32 42] The 2021 European Resuscitation Guidelines recommend the omission of suction even for newborns born in thick meconium as it delays ventilation and there is an absence of evidence of benefit.[16] It has been argued that the suction device should be removed from the resuscitation table and observations from our study support this as critical time is diverted to suctioning instead of ventilation. [26] The AMANHI study attributed perinatal asphyxia as the leading cause of death responsible for more than 47% of neonatal deaths in Pemba. [34]. In addition, the Zanzibari Ministry of Health reports birth asphyxia as the leading cause of death in children under 13 years, accounting for 25.2 % of deaths.[43]

Lastly, we report an NMR of 23.6 per 1000 live births, with more than 90% of the deaths occurring within the first 24 hours. Our one-day neonatal mortality is higher than most of the literature, suggesting that the overall neonatal mortality rate in Pemba could be much higher than we report. [3-5 12] The NMR in our study is slightly higher than the official numbers from the Zanzibari Ministry of Health and the AMANHI-study group. [34 44]

Challenges in provision of quality of care according to guidelines have many reasons beyond the capacity of HWs, including structural barriers such as lack of human resources, lack of equipment and logistical challenges. Maaløe et al. recommend local adaptation of guidelines, so they are achievable and contextualised to the setting.[45] In addition, there is a need to understand the barriers to adhere to the guidelines, such as HBB and similar NRP, to succeed and translate into improvements in knowledge and skills and improve neonatal outcomes. Novel technology such as mHealth tools are widely available. A study showed that the Safe Delivery App aids knowledge and skill retention with a non-significant reduction of perinatal mortality, and mHealth solutions such as this could be part of the solution. [46]

Strengths and limitations

A significant strength of this study is the video as a data source, allowing the definition of birth care in the time resolution of seconds and perhaps reducing the Hawthorne effect of an observer being present.[47]

Another strength is the study of four moderate volume district hospitals, as most of the research from LMIC is from high volume tertiary hospitals. This study, however, also has limitations. Our enrolment rate was 66 % and the ethical consent procedures did not include a waiver of consent. Seven women who were enrolled before birth and suffered an immediate neonatal death did not want to participate with further information. Another limitation was that our study's village follow-up component was made impossible by Covid-19, resulting in a nearly 40% loss-to-follow-up to 28 days. Finally, 61 resuscitations were not captured on video. Reasons hereof have been listed previously. [33]

Conclusion

In conclusion, our study found that video recording of neonatal resuscitation in secondary-level district hospitals in a low-resource setting revealed significant derivations from NR guidelines despite nearly 90% of health workers having received training in NR. The neonatal mortality rate was 23.6 per 1000 live births. The video recordings provided direct evidence of gaps in quality of care, and were instrumental in identifying areas for future education, particularly efforts on effective bag- and mask ventilation.

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Author Contributions

SL, AP, CCHH and GG conceived the idea for the study. CCHH, TBS, UAM and JM collected the data. CCHH wrote the first draft of the manuscript. CCHH, AP and SL have verified the data, and CCHH performed statistical analysis with statistical consultancy. CCHH, SL and CNS performed video analysis. SL is the guarantor of the study. CCHH and SMA were the principal investigators of the study. All authors read and approved the final version of the manuscript.

Declaration of Conflicting Interests

No potential conflict of interest was reported by the author(s).

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Role of the funding source

The study's funders had no role in study design, data collection, analysis, interpretation, or report writing.

Ethical Approval

The study was approved by the Zanzibar Health Research Institute (NO.ZAHREC/02/August/2019/30). Informed consent was obtained from study participants according to local requirements. Institutional permission and individual health worker informed consent were also acquired.

Data Availability

The data is available upon reasonable request from the corresponding author.

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References.docx available at https://authorea.com/users/543851/articles/601427-video-assessment-of-health-worker-performance-in-neonatal-resuscitation-in-four-district-hospitals-in-pemba-tanzania-a-prospective-cohort-study

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