

# Assessment of neonatal resuscitation skills among healthcare workers in Uasin Gishu County, Kenya

SAGE Open Medicine

Volume 10: 1–7

© The Author(s) 2022

Article reuse guidelines:

[sagepub.com/journals-permissions](https://sagepub.com/journals-permissions)

DOI: 10.1177/20503121221119296

[journals.sagepub.com/home/smo](https://journals.sagepub.com/home/smo)

Pauline T Kamau<sup>1</sup> , Myra Koech<sup>2</sup>, Shaina M Hecht<sup>3</sup>,  
Megan S McHenry<sup>3</sup> and Julia Songok<sup>2</sup>

## Abstract

**Objective:** Neonatal resuscitation is key in preventing neonatal mortality. The objective of this study was to assess the competence of healthcare workers in basic neonatal resuscitation at six hospitals in Uasin Gishu County in Kenya.

**Methods:** This was a cross-sectional study of healthcare workers based on the labor and delivery wards.

**Results:** Of the 46 healthcare workers who were assessed with a written examination and skills assessment, 85% were nurses. While 46% were able to pass the written examination, none demonstrated all required steps of newborn resuscitation during the skills assessment by simulation. No significant associations were present between the pass rate of the written examination and years of experience, role, or prior in-service training. All of the hospitals had the basic equipment required for neonatal resuscitation.

**Conclusion:** There is a need to further develop the neonatal resuscitation skills among healthcare workers in the labor and delivery wards in Uasin Gishu County, Kenya.

## Keywords

Newborn resuscitation, equipment, healthcare provider, delivery room, simulation, Kenya

Date received: 4 February 2022; accepted: 18 July 2022

## Introduction

Effective neonatal resuscitation is essential in reducing mortalities and morbidities attributable to birth asphyxia.<sup>1</sup> In low- and middle-income countries (LMICs), where over 95% of neonatal deaths occur, ineffective basic resuscitation or a delay in resuscitation response contributes to the significant burden of neonatal mortality and morbidity.<sup>2</sup> Training of healthcare workers (HCWs) in LMICs has been directly linked with the improvement of neonatal outcomes.<sup>3,4</sup> Multiple standardized neonatal resuscitation training programs have been specifically designed for use in LMICs setting to address the high burden of neonatal mortality, such as Emergency Triage Assessment and Treatment (ETAT+), Emergency Obstetric and Neonatal Care (EmONC), and Helping Babies Breathe (HBB).<sup>5–7</sup> However, the dissemination of knowledge gained from neonatal resuscitation training programs is not clearly known.

In a retrospective cohort study based in Kenya, a study team found that approximately 10% of neonates delivered within a hospital setting and admitted to a neonatal care

setting died within their first month of life, although this percentage varies by hospital settings (5%–17%), with intrapartum-related complications being the leading cause of death in this setting.<sup>8,9</sup> Within the county of Uasin Gishu, Kenya, a total of 31,547 babies were born in 2020 and 458 died in their first month of life, an estimated mortality rate of 1.4%.<sup>10</sup> Within Uasin Gishu County, a large teaching and referral hospital trains student nurses and clinical practitioners on appropriate neonatal resuscitation techniques as part of their curriculum and advanced newborn resuscitation equipment is available. However, within the sub-county

<sup>1</sup>School of Medicine, Moi University, Eldoret, Kenya

<sup>2</sup>Department of Pediatrics and Child Health, School of Medicine, Moi University, Eldoret, Kenya

<sup>3</sup>Division of Pediatric Infectious Diseases and Global Health, Department of Pediatrics, School of Medicine, Indiana University, Indianapolis, IN, USA

### Corresponding author:

Pauline T Kamau, School of Medicine, Moi University, Eldoret 30100, Kenya.

Email: [thirimup@gmail.com](mailto:thirimup@gmail.com)



hospitals, less is known about the HCWs' competence and capacity to perform neonatal resuscitation.

This study sought to assess the competence of the HCWs on basic neonatal resuscitation at the six sub-county hospitals in Uasin Gishu County, Kenya. We specifically assessed their knowledge and skills using a written examination and a skills assessment, explored the factors associated with having the appropriate knowledge and skills, and assessed for the availability and condition of basic resuscitation equipment at each hospital.

## Methods

### *Study design and population*

This was a descriptive cross-sectional study conducted between 1 January and 31 July 2016 in six sub-county hospitals within Uasin Gishu County, Kenya: Huruma, Ziwa, Kesses, Burnt Forest, Uasin Gishu, and Kapteldon. Ziwa and Huruma sub-county hospitals have the highest average number of annual newborn deliveries (up to 1200 deliveries per year—considered “high volume”), followed by Uasin Gishu sub-county hospital (approximately 760 deliveries per year—“intermediate volume”). Kesses and Burnt Forest sub-county hospitals perform on average 440 deliveries per year (“intermediate volume”). Kapteldon sub-county hospital performs the least average number of deliveries at 250 per year (considered “low volume”).

At the time of this study, there were a total of 57 HCWs assigned to labor and delivery units within the six hospitals, which included registered nurses, enrolled nurses, clinical officers, and medical officers. Forty-six HCWs were present during the study period and recruited into the study whereas 11 were on leave during that time; no sample size analysis was completed. Due to differences in training requirements for HCWs internationally, we outline the training required for each role: an enrolled nurse undergoes 2.5 years of post-secondary training, and is considered at a certificate level. A registered nurse completes 3.5 years of post-secondary training, and is considered at a diploma level, which is less education than a bachelor's degree. A medical officer is a non-specialized physician who has completed a 6-year bachelor's degree in medicine and 1 year of internship. A clinical officer completed 3 years of post-secondary training, is considered at a diploma level in clinical medicine, and is supervised by a medical officer.

The standardized neonatal resuscitation training programs are designed for LMICs and are applicable across the cadres of nurses, medical officers and clinical officers. These trainings are similar in how they use didactic and simulation approaches to education of basic newborn resuscitation, but their administration may differ. Some trainings may be incorporated in formal post-secondary educational training while others are offered as refresher courses for healthcare providers.

Ethical approval to conduct the study was given by the Institutional Research and Ethics Committee (IREC) of Moi

University/MTRH, and permission was granted by the Uasin Gishu County Ministry of Health. All HCWs provided written consent to participate in the study.

### *Data collection*

Each study participant completed a questionnaire, written examination, and skill assessment over the span of 7 days. Each of the six sub-county hospitals was also assessed for availability of equipment used for neonatal resuscitation.

The questionnaire included basic questions about the HCWs' training and experience with neonatal resuscitation (Supplemental Appendix 1). The written examination included knowledge-based questions which covered basic newborn resuscitation skills, including immediate resuscitation steps, methods of airway clearance, and ventilatory techniques. The answers to these questions were formatted as multiple-choice options, and the content was derived from the Neonatal Textbook of Resuscitation, Sixth Edition (Supplemental Appendix 2).<sup>11</sup> A neighboring sub-county hospital in Mosoriot is staffed by HCW with similar training and backgrounds as those within this study site. Twenty-five per cent of HCW in Mosoriot were selected to pre-test the questionnaire, to ensure the question items were clear. For this study, the written examination was administered to the study participants during clinical duty hours. All examinations were performed under the supervision of the Principal Investigator whose initials are P.T.K. and Research Assistant, A.S. Both were resident physicians in pediatrics and trained in ETAT+ neonatal resuscitation, with A.S. having more substantial experience in training HCWs on ETAT+ neonatal resuscitation. If a patient care need arose during the examination period, the study participant was allowed to attend to the patient and complete the exam unsupervised within 7 days of beginning the examination. A score of 80% or above on the six-question examination (missing only one or no items) was considered to be a passing grade.

After the written examination, the skills assessment was administered, using an infant manikin. When possible, these skills and written assessments were completed on the same day, but if that was not possible, the skills assessment was administered within 7 days of the written examination. The skills assessment was comprised of two common neonatal scenarios (Supplemental Appendix 3), adopted from ETAT+ curriculum and modified to suit the objectives of the study.<sup>5</sup> Of note, at the time of this study, neonatal resuscitation protocol (NRP) recommended routine suctioning for the resuscitation of a non-vigorous newborn with meconium, but has since been updated to immediate care similar to a newborn delivered in clear fluid.<sup>12</sup> P.T.K. and A.S. read the scenario prompt to the participant and would request the participant read back the scenarios to ensure that it was understood. The participant was then prompted to demonstrate the appropriate next steps of action on the manikin, or their thought process, if applicable. The critical steps were drying the baby,

assessing the airway, assessing for breathing, calling for help, and giving 30 ventilations in 1 min. In cases where the participant did not immediately verbalize the next step, they were prompted with questions. P.T.K. and A.S. then independently scored the participant based on whether each step was achieved or not achieved. In instances of incongruity, the AS score was used given their previous experience with ETAT+ trainings. After the completion of the second scenario, the participants were commended on the steps achieved and corrected on the steps that were not achieved.

The resuscitation equipment was then assessed for availability and functionality at each hospital (Supplemental Appendix 4) by P.T.K. This included a resuscitation table, radiant warmer, two towels, suction machine, bulb syringe, self-inflating bag, face mask (size 0 and 1), and a clock or stopwatch. Equipment kept in the stock room was considered absent.

### Statistical analysis

Frequency listings and percentages were used for sociodemographic data and knowledge scores. Performance on skills assessment was presented in frequency listings. The measure of agreement between the two assessors on skills was compared using intraclass correlation coefficient (ICC3). The Pearson chi-square test was used to test for association between knowledge performance and HCW characteristics, and Bayesian generalized linear modeling was used to assess predictors for passing rates on knowledge assessment. We looked at different models: (1) passing rates with newborn resuscitation frequency and hospital as predictors and (2) passing rates with newborn resuscitation frequency and work years as predictors. We used a Bayesian generalized linear model rather than basic logistic regression because of the limited numbers within cells.<sup>13</sup> Data were analyzed using STATA version 14 at 95% confidence interval, and  $p$ -value < 0.05 was considered statistically significant.

## Results

### Characteristics of the HCWs

Of the 46 HCWs, 38 (82.6%) were registered nurses and one was an enrolled nurse. Approximately half of the HCWs ( $n=21$ ) had previously received in-service training on newborn resuscitation. The majority ( $n=16$ , 73%) of those who were not trained in neonatal resuscitation reported that they had never heard about the trainings, 6 (24%) reported that they were too busy at work to attend the trainings, 2 reported that they were not interested, and 1 reported that it was too expensive. All who had not been trained indicated that they wished to be trained in newborn resuscitation. The majority of the respondents ( $n=39$ , 85%) reported performing less than 5 newborn resuscitations in the past 3 months, which was noted to be spread

**Table 1.** Characteristics and training background of the 46 healthcare workers.

	<i>n</i> (%)
Designation	
Medical officer	2 (4)
Clinical officer	5 (11)
Registered nurse	38 (83)
Enrolled nurse	1 (2)
Age (years)	
Under 25	1 (2)
25–35	23 (50)
>35	22 (48)
Gender	
Female	36 (78)
Male	10 (22)
Years of experience <sup>a</sup>	
Under 2	14 (30)
2–5	14 (30)
>5	18 (39)
Trained in neonatal resuscitation	
No	25 (54)
Yes	21 (46)
Type of training <sup>a</sup>	
None	25 (54)
ETAT+	1 (2)
EmONC	18 (39)
Essential newborn care	2 (4)

*n*: number; ETAT+: Emergency Triage Assessment and Treatment; EmONC: Emergency Obstetric and Neonatal Care.

<sup>a</sup>Due to rounding, total percentages add to 99.

equally across the high and low volume hospitals. The demographics of the HCWs are reported in Table 1.

### Scores of the written examination and skills assessment

More than half ( $n=25$ , 54%) of the HCWs failed to achieve a passing score on the written examination. The responses to each of the six questions of neonatal resuscitation are reported in Table 2 to identify areas in which the HCWs' knowledge was deficient. The most common incorrect answer was proper head positioning for positive pressure ventilation (PPV), with 65% of participants answering incorrectly. This was followed by ventilation rate with 41% participants answering incorrectly.

In comparing the demographics of the HCWs and their ability to pass the written examination, there was no significant difference in role, years of experience, or prior neonatal resuscitation training (Table 3).

The performance among the HCWs in each hospital was compared, and there was no significant difference in passing rates of HCWs between the high volume delivery hospitals and low volume hospitals ( $p$ -value=0.698, Figure 1). Furthermore, within our two modeling strategies to examine

**Table 2.** Newborn resuscitation written examination results.

Question	Correct answer achieved, n (%)
Indication for resuscitation	42 (91)
Indication for airway suction	40 (87)
Indication for newborn stimulation	33 (72)
Order of resuscitation steps	43 (94)
Head positioning for PPV	16 (35)
Ventilation rate	27 (59)

n: number; PPV: positive pressure ventilation.

passing rates with newborn resuscitation frequency and either hospital or work years as predictors, none of these were predictors for passing rates.

A total of 42 HCWs were scored during the skills assessment, as four participants dropped out of the study after the written test. Table 4 details each step of the skills assessed during simulation. For each step, the skill was assessed as the participant described their thought process or if applicable, performed the skill.

The steps most commonly performed were warming the baby, with 81% of HCWs performing it, and drying the baby, performed by 71%. Effective ventilation (giving 30 breaths for 1 min) and observing tone, color, and respiratory effort were the least frequently performed, with only 5% of the HCWs demonstrating these skills. None of the HCWs were able to perform all eight parts of the skills assessment for both scenarios, and therefore, further analysis in comparing results by level of training or prior neonatal resuscitation training was not completed.

The ICC, a measure of the reliability of the assessors, was 0.66, which translates to good agreement between the assessors.

### Resuscitation equipment

All of the hospitals had a functional resuscitation table, warmer, vacuum machine, bulb suction, and bag mask size 1. None of the hospitals had a size 0 face mask. In the hospitals without towels and/or clocks, the HCWs reported using the mother's clothes and wristwatch or mobile phone at the time of delivery in their place. While all hospitals had functional tables, some of these hospitals' tables were modified from the typical resuscitation tables used within high-resourced delivery settings. These modified tables consisted of a mattress on a concrete working surface, placed next to a radiant warmer.

### Discussion

We assessed the knowledge and skill of HCWs on labor wards in basic neonatal resuscitation, evaluated associations on passing rates of the written examination, and assessed the availability of required neonatal resuscitation equipment in all six sub-county hospitals in Uasin Gishu County, Kenya.

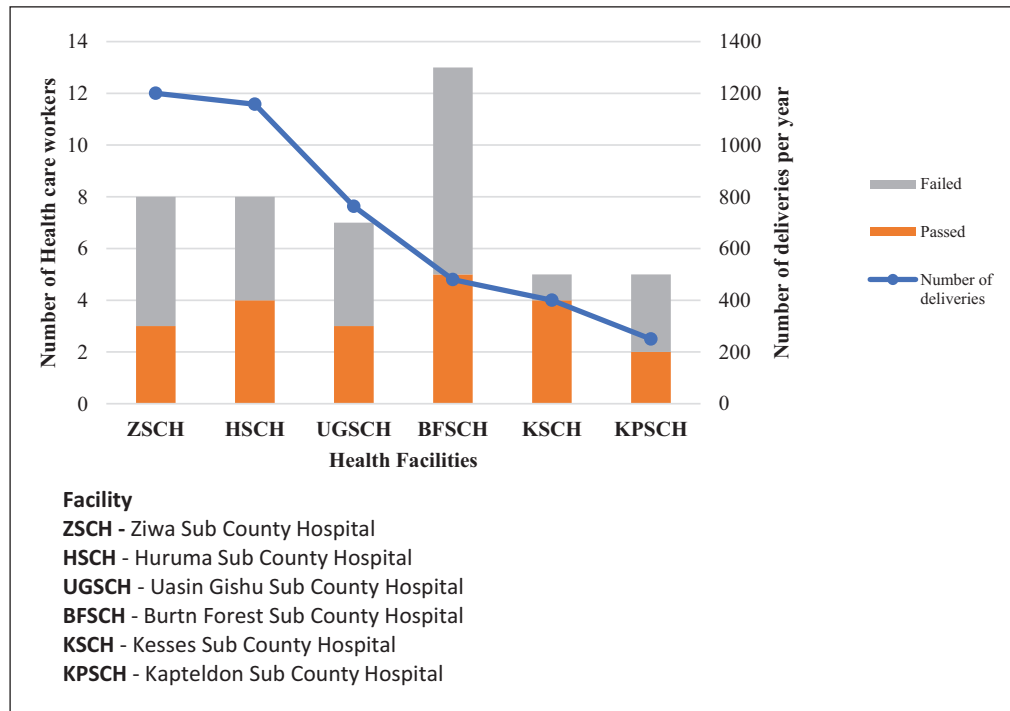
**Table 3.** Knowledge performance and associated factors in healthcare workers.

Variable	Pass (%)	p-value ( $\chi^2$ )
Role		0.4110
Medical officer	0 (0)	
Clinical officer	2 (40)	
Registered nurse	19 (50)	
Enrolled nurse	0	
Years of experience		0.519
Under 2	5 (36)	
2–5	8 (57)	
>5	8 (44)	
Trained in neonatal resuscitation		0.979
No	9 (46)	
Yes	9 (43)	
Number of newborn resuscitations performed in past 3 months		0.173
<5	20 (51)	
5–10	1 (20)	
>10	0	

It was found that the majority of the HCWs ( $n=25$ , 54%) did not have adequate knowledge on newborn resuscitation to pass the written examination. This is aligned in knowledge levels found in non-tertiary settings elsewhere in LMICs. In rural facilities of Ethiopia and Tanzania, a low level of newborn resuscitation knowledge among HCWs was identified.<sup>14–16</sup> Conversely, in a tertiary-care hospital in Nepal, all HCWs assessed on knowledge prior to training performed above average.<sup>17</sup> The critical areas of deficiency identified in our written assessment included head positioning and ventilation rate. In Southern Ethiopia, about 4 in 10 midwives did not identify the appropriate head position in newborn resuscitation in a written assessment, and more than half of pediatric healthcare doctors in Pakistan did not know how to maintain the airway.<sup>14,18</sup> By identifying these knowledge gaps in the HCWs in this study, it provides areas to focus on during future trainings.

We found no difference in pass rates between nurses and physicians or between years of experience and prior in-service training. Studies done in Tanzania, Ethiopia, and the USA have indicated a positive association between adequate knowledge and experience of more than 5 years in maternity units, including previous training on newborn resuscitation and current NRP training.<sup>16,19,20</sup> However, our small sample size may have lacked adequate power to identify predictors of performance on neonatal resuscitation knowledge and skills.

On the skills assessment, none of the HCWs performed all eight steps of neonatal resuscitation in the correct sequence and technique. Notably, demonstration of effective ventilation with bag-valve mask, the most critical step in neonatal resuscitation, was achieved by only two (5%) HCWs. This is similar to a study in Nepal where none of the HCWs were competent in this step prior to training in a simulation setting



**Figure 1.** Knowledge performance across the six hospitals, in terms of pass/fail and number of deliveries per year.

**Table 4.** Newborn resuscitation skills assessment results.

Skill	Correct skill achieved, n (%)
Warm baby	34 (81)
Dry baby <sup>a</sup>	30 (71)
Observe tone, color, and respiratory effort	2 (5)
Assess airway <sup>a</sup>	24 (57)
Assess breathing <sup>a</sup>	14 (33)
Call for help <sup>a</sup>	4 (10)
Give 30 breaths for 1 min <sup>a</sup>	2 (5)

<sup>a</sup>Indicates a critical step.

using a manikin.<sup>17</sup> In this study, there were no periodic reviews on performance, a measure which has been associated with clinical skill improvements in combination with other strategies.<sup>17</sup> Other critical steps that were performed by only a minority of HCWs in this study include calling for help and assessing for breathing, similar to findings from a study in Afghanistan where HCWs in delivery rooms only called for help in 26% of the cases requiring resuscitation.<sup>21</sup> Skills related to the universal care for newborns immediately after birth (i.e. drying and warming baby) were performed best. Similar to our findings, adequate routine newborn care skills were more often performed compared to neonatal resuscitation skills in other low-resourced settings.<sup>22</sup>

There are several reasons that could possibly explain the inadequacy of skills among the Kenyan HCWs. First, the

majority of HCWs had worked in the maternity unit for less than 5 years, which has been associated with limited skills in neonatal resuscitation.<sup>16</sup> Furthermore, most of the deliveries at these sub-country hospitals are performed by a single HCW; hence, there is no practice of calling for help if there is a need for resuscitation, a critical step that we assessed. Finally, the majority of the HCWs assessed had not had any in-service training on neonatal resuscitation, despite practicing for more than 2 years. Therefore, they had possibly lost skills acquired during their professional training. While the majority of the HCWs had not been trained or were not aware of newborn resuscitation courses, nearly all were willing and interested to be trained. It is imperative that HCWs in rural areas get adequate exposure to such trainings to foster their skills. In contrast to the results of this study, another study performed in a neighboring county in western Kenya found better performance of neonatal resuscitation skills, such as the assessment of breathing, drying and stimulation, and initiation of bag and mask ventilation.<sup>23</sup> Of note, this study, set in Kakamega County, Kenya, performed direct observation of HCWs in the labor ward during clinical care, rather than within a simulated scenario.<sup>23</sup> It is possible that our use of a low fidelity simulation assessment may not be representative of the true response that HCWs are likely to have in real-life scenarios within the delivery room.

The basic resuscitation equipment was largely available and functional in all six hospitals, except towels and a clock which were lacking in half. Similarly, some facilities in Ethiopia and Vietnam lacked towels and clocks, respectively.<sup>24,25</sup> Availability of essential equipment has

been linked with increased survival of neonates after neonatal resuscitation.<sup>24</sup> Therefore, our evaluation reveals the need for better provision of all essential resuscitation equipment among non-tertiary hospitals in order to improve the survival rate of neonates. A significant concern that arose was the lack of appropriate mask sizes for ventilating preterm newborns, which is a critical step in neonatal resuscitation. This is a major gap that needs to be addressed in order to improve the care of preterm babies at birth, who have a higher need for resuscitation.<sup>26</sup>

One limitation to this study is that it was carried out in only one of the 47 counties in Kenya, and therefore, the results may not be generalizable to the rest of Kenya or another resource-limited country. However, for local monitoring and evaluation, this study provides critical insights on areas to be prioritized for future training needs. In addition, the HCWs were assessed irrespective of their level of experience in the delivery room and the duration from their last in-service training. Therefore, the study participants may not represent a homogeneous group. Yet we believe that this study population represents a typical team of labor and delivery HCWs in a sub-county hospital in Kenya. In addition, we did not complete a sample size analysis as we wanted to include all available HCWs from the sub-county hospitals. Finally, we did not use an externally standardized exam for the newborn resuscitation knowledge assessment, although the questions were based on the NRP training materials and were deemed to be representative of knowledge needed to perform neonatal resuscitation in a low-resource setting.

Given the low passing rates of the written examination and skills assessment and low participation in neonatal resuscitation training, more efforts are needed to ensure HCWs providing labor and delivery care have regular refresher courses to maintain skills over time. From this study, it was clear that despite unawareness of newborn resuscitation courses, HCWs were willing to be trained. This is an opportunity for intervention from the health stakeholders in Uasin Gishu County. In many high-income settings, NRP requires HCWs working within the labor and delivery clinical areas to be recertified every 2 years to maintain their knowledge and skills.<sup>27</sup> Currently in Kenya, Comprehensive Newborn Care protocols are being drafted and will include a recommendation for every skilled birth attendant to be receive in-service training and regular refresher sessions on newborn resuscitation at least once every 12 months. Among courses that are taught in the country, such as HBB, there is no definite frequency of practice and refresher training stipulated to maintain proficiency.<sup>28</sup> However, ongoing low-dose high-frequency practice is recommended to improve performance and competency.<sup>28</sup> In view of the study findings, we highly recommend training of HCWs in newborn resuscitation and a mechanism implemented to ensure skills retention either through refresher trainings or ongoing skills practice.

## Conclusion

We found critical areas of improvement for neonatal resuscitation knowledge and skills within HCWs at six sub-county hospitals in western Kenya, with appropriate head positioning and PPV being identified as key areas of growth. While all of the hospitals had basic functioning equipment for neonatal resuscitation, none of the hospitals had the appropriate face mask to accommodate ventilation of a premature infant, which is a critical and common need within these settings. Regular neonatal resuscitation training and equipment evaluations for all HCWs in labor wards are required to optimize care for newborns within these settings.

## Acknowledgements

The authors specially thank Dr Justus Simba for facilitating standardization of newborn skills assessment prior to data collection by the Principal Investigator and Research Assistant, and Dr Eric Ngetich for providing the manikins used in data collection. We also acknowledge Dr Ann Sogomo as a research assistant who played a role in assessment of skills.

## Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Ethical approval

Ethical approval to report this case was obtained from Moi University, School of Medicine, Moi Teaching Referral Hospital, Institutional Research and Ethics Committee (IREC) Approval number: 0001485.

## Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

## Informed consent

Written informed consent was obtained from the patient(s) for their anonymized information to be published in this article. Written informed consent was obtained from every healthcare worker who participated in this research.

## ORCID iD

Pauline T Kamau  <https://orcid.org/0000-0003-0777-217X>

## Supplemental material

Supplemental material for this article is available online.

## References

1. O'Curra E, Davis PG and Thio M. Educational perspectives: toward more effective neonatal resuscitation—assessing and improving clinical skills. *Neoreviews* 2019; 20(5): e248–e257.
2. GBD 2019 under-5 Mortality Collaborators. Global, regional, and national progress towards Sustainable Development Goal 3.2 for neonatal and child health: all-cause and cause-specific

- mortality findings from the Global Burden of Disease Study 2019. *Lancet* 2021; 398(10303): 870–905.
3. Moshiro R, Mdoe P and Perlman JM. A global view of neonatal asphyxia and resuscitation. *Front Pediatr* 2019; 7: 489.
  4. Pammi M, Dempsey EM, Ryan CA, et al. Newborn resuscitation training programmes reduce early neonatal mortality. *Neonatology* 2016; 110(3): 210–224.
  5. Irimu G, Wamae A, Wasunna A, et al. Developing and introducing evidence based clinical practice guidelines for serious illness in Kenya. *Arch Dis Child* 2008; 93(9): 799–804.
  6. Otolorin E, Gomez P, Currie S, et al. Essential basic and emergency obstetric and newborn care: from education and training to service delivery and quality of care. *Int J Gynaecol Obstet* 2015; 130(Suppl. 2): S46–S53.
  7. Perlman JM, Velaphi S, Massawe A, et al. Achieving country-wide scale for helping babies breathe and helping babies survive. *Pediatrics* 2020; 146(Suppl. 2): S194–S207.
  8. Masaba BB and Mmusi-Phetoe RM. Neonatal survival in sub-Saharan: a review of Kenya and South Africa. *J Multidiscip Healthc* 2020; 13: 709–716.
  9. Irimu G, Aluvaala J, Malla L, et al. Neonatal mortality in Kenyan hospitals: a multisite, retrospective, cohort study. *BMJ Glob Health* 2021; 6(5): e004475.
  10. Ministry of Health Kenya. District health information system (DHIS2), October, 2021, <https://hiskenya.org/dhis-web-pivot/> (accessed 8 October 2021).
  11. *NRP neonatal resuscitation textbook*. 6th ed. Itasca, IL: American Academy of Pediatrics, 2011.
  12. Zaichkin JG. Neonatal resuscitation: neonatal resuscitation program 7th edition practice integration. *Crit Care Nurs Clin North Am* 2018; 30(4): 533–547.
  13. Gelman A, Jakulin A, Pittau MG, et al. A weakly informative default prior distribution for logistic and other regression models. *Annal Appl Stat* 2008; 2(4): 1360–1383.
  14. Arba A and Zana Z. Knowledge of essential newborn care and associated factors among nurses and midwives: a cross-sectional study at public health facilities in Wolaita Zone, Southern Ethiopia, 2019. *Int J Pediatr* 2020; 2020: 3647309.
  15. Sintayehu Y, Desalew A, Geda B, et al. Knowledge of basic neonatal resuscitation and associated factors among midwives and nurses in public health institutions in Eastern Ethiopia. *Int J Gen Med* 2020; 13: 225–233.
  16. Joho AA, Kibusi SM and Mwampagatwa I. Predictors of Helping Babies Breathe knowledge and skills among nurses in primary health settings in Dodoma region, Tanzania. *BMC Pregn Childb* 2020; 20(1): 150.
  17. Kc A, Wrammert J, Nelin V, et al. Evaluation of Helping Babies Breathe Quality Improvement Cycle (HBB-QIC) on retention of neonatal resuscitation skills six months after training in Nepal. *BMC Pediatr* 2017; 17(1): 103.
  18. Muneer A, Bari A, Haider A, et al. Knowledge of clinicians/pediatricians about neonatal resuscitation in a tertiary care hospital. *Pak J Med Sci* 2019; 35(3): 775–779.
  19. Abrha MW, Asresu TT, Araya AA, et al. Healthcare professionals' knowledge of neonatal resuscitation in Ethiopia: analysis from 2016 national emergency obstetric and newborn care survey. *Int J Pediatr* 2019; 2019: 8571351.
  20. Drzymalski DM, Gao W, Moss DR, et al. Factors associated with neonatal resuscitation knowledge and comfort across academic anesthesia institutions. *J Matern-Fetal Neonat Med*. Epub ahead of print 9 November 2020. DOI: 10.1080/14767058.2020.1843018.
  21. Atiqzai F, Manalai P, Amin SS, et al. Quality of essential newborn care and neonatal resuscitation at health facilities in Afghanistan: a cross-sectional assessment. *BMJ Open* 2019; 9(8): e030496.
  22. Tosif S, Jatobatu A, Maepioh A, et al. Healthcare worker knowledge and skills following coaching in WHO early essential newborn care program in the Solomon Islands: a prospective multi-site cohort study. *BMC Pregn Childb* 2020; 20(1): 84.
  23. Shikuku DN, Milimo B, Ayebare E, et al. Practice and outcomes of neonatal resuscitation for newborns with birth asphyxia at Kakamega County General Hospital, Kenya: a direct observation study. *BMC Pediatr* 2018; 18(1): 167.
  24. Weldearegay HG, Abrha MW, Hilawe EH, et al. Quality of neonatal resuscitation in Ethiopia: implications for the survival of neonates. *BMC Pediatr* 2020; 20(1): 129.
  25. Trevisanuto D, Cavallin F, Arnolda G, et al. Equipment for neonatal resuscitation in a middle-income country: a national survey in Vietnam. *BMC Pediatrics* 2016; 16(1): 139.
  26. Marshall S, Lang AM, Perez M, et al. Delivery room handling of the newborn. *J Perinat Med* 2019; 48(1): 1–10.
  27. Weiner GM and Zaichkin J (eds). *Textbook of neonatal resuscitation*. 8th ed. Itasca, IL: American Academy of Pediatrics, 2021.
  28. Kamath-Rayne BD, Thukral A, Visick MK, et al. Helping babies breathe, second edition: a model for strengthening educational programs to increase global newborn survival. *Glob Health Sci Pract* 2018; 6(3): 538–551.