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Development and pilot implementation of a co-designed nationally accredited advanced neonatal nursing curriculum in Tanzania

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Abstract: *Introduction*
Tanzania has greater neonatal deaths (21 deaths per 1000 live births) compared to the goal (12 deaths per 1000 live births) described by the United Nations Sustainable Development Goals. The World Health Organization recommended decreasing training variation and increasing capacity of neonatal nurses to address neonatal mortality. This project co-designed and implemented a neonatal nursing curriculum in a Tanzanian hospital to improve skills and knowledge.
Methods: Kern's Six Steps was used for curriculum development by a multi-national, interdisciplinary team. A needs assessment evaluated clinical topics and skills. A ten-month hybrid virtual and in-person curriculum with assessments in a flipped classroom model with pre-recorded lectures and scheduled discussion sessions was developed. The curriculum was accredited by the Tanzania Nursing and Midwifery Council to provide continuous professional development points and a sustainable local platform for the material.
Results: The needs assessment demonstrated physical examination, respiratory system, gestational age assessment, and resuscitation as most important and frequently used topics in clinical practice. Participants who completed both pre-curriculum and post-curriculum assessments demonstrated mixed results with scores. The six-month retainment assessment demonstrated overall improvement in knowledge (mean +7%) compared to the post-curriculum assessment.
Conclusion: Currently, the team is refining the curriculum to combine education with bedside skills training in the next expansion efforts to the remainder of nurses in the Neonatal Ward, other hospital sites, and referring community sites. The impact on specific clinical outcomes, such as PIV infiltrates and unplanned extubations, will be evaluated to speak to higher levels of the Kirkpatrick Model.

Résumé: *Introduction:* La mortalité néonatale en Tanzanie demeure élevée, avec 21 décès pour 1 000 naissances vivantes, au-dessus de l'objectif des objectifs de développement durable fixé à 12 pour 1 000. L'Organisation mondiale de la Santé recommande de réduire les variations dans la formation et de renforcer les compétences des infirmiers et infirmières en néonatologie afin d'améliorer la survie néonatale. Ce projet visait à co-concevoir et mettre en œuvre un curriculum de formation en soins infirmiers néonatals dans un hôpital tanzanien afin d'améliorer les connaissances et les compétences cliniques.
Méthodes: Le curriculum a été élaboré selon le modèle des six étapes de Kern par une équipe multinationale et interdisciplinaire. Une évaluation des besoins a permis d'identifier les thèmes et compétences prioritaires. Un programme de formation hybride, combinant enseignement virtuel et présentiel sur dix mois, a été déve

développé selon le modèle de la classe inversée, incluant des cours préenregistrés et des sessions de discussion. Le programme a été accrédité par le Conseil tanzanien des infirmiers et sages-femmes, permettant l'obtention de points de formation professionnelle continue et assurant la durabilité du dispositif.
Résultats: L'évaluation des besoins a mis en évidence comme priorités l'examen clinique, la prise en charge du système respiratoire, l'évaluation de l'âge gestationnel et la réanimation néonatale. Les comparaisons entre les évaluations pré- et post-formation ont montré des résultats variables. Toutefois, l'évaluation de rétention à six mois a démontré une amélioration globale des connaissances, avec une augmentation moyenne de 7 % par rapport à l'évaluation post-formation.
Conclusion: Le curriculum est en cours d'amélioration afin d'intégrer davantage de formation pratique au lit du patient et d'être étendu à l'ensemble du personnel infirmier néonatal, à d'autres hôpitaux et aux structures de référence communautaires. L'impact sur des résultats cliniques spécifiques, tels que les infiltrations de voies veineuses périphériques (PIV) et les extubations non planifiées, sera évalué afin d'apprécier les niveaux supérieurs du modèle de Kirkpa-

Introduction

Despite the under-five mortality rate decreasing globally over the past decade, neonatal mortality has not decreased accordingly, with the proportion of neonatal mortality increasing and now comprising nearly half of all the deaths in children under the age-five globally.[1] The distribution of neonatal mortality remains inequitable with the highest burdens remaining in low- and middle-income countries (LMIC), mostly within Sub-Saharan Africa and South Asia.[1]

In Tanzania, there has been a slow decrease in neonatal mortality rate in the past decade from 24 deaths per 1000 live births to 21 deaths per live births in 2023.[2] This mortality rate remains nearly double that of the proposed goal of less than 12 neonatal deaths per 1000 live births by 2030 as put forth by the Sustainable Development Goals.[3] In Tanzania, a 2022 report highlighted the leading contributors to neonatal mortality: birth asphyxia, prematurity, and sepsis.[4] These mirror the leading causes to global neonatal mortality.[1] The Dar es Salaam region in Tanzania has the highest early neonatal deaths (within the first seven days after birth) in the country.[5] The neonatal mortality rate at a large federal tertiary referral hospital in Dar es Salaam, is on average 10.7% of all admissions from 2018 to 2020.[6]

The World Health Organization (WHO) recognizes infant death in the first 28 days of life in Sub-Saharan Africa can be in part attributed to limitations in nursing care. Critical recommendations include decreasing training variation and increasing capacity of neonatal nurses.[7] Nurses are fundamental members of the medical care team and always remain with patients. Improving nursing neonatal knowledge and skills could greatly improve neonatal outcomes on a global scale. Research has shown that high quality nurses' education at the baccalaureate and higher levels has been linked to better patient outcomes.[8,9,10] In addition, specialty certification achieved by nurses has positive impact on some patient outcomes, such as healthcare associated infections.[11] However, many training centers in Sub-Saharan Africa lack protected education time and resources to provide specialty neonatal nursing. The WHO and others have proposed several solutions including global partnerships between high-income countries and LMICs that center on neonatal nursing capacity building to further expand the quality of newborn care and ultimately save neonatal lives.[7]

As part of a longstanding bidirectional partnership between a Tanzanian hospital and United States (US) academic research university, the need for a structured neonatal nursing education was self-identified by nurses in the Tanzanian Neonatal Ward. The goal of the project was to develop and implement an advanced neonatal nursing curriculum with objectives including:

(1) Complete a formal focused educational needs assessment,
(2) Co-design a neonatal nursing curriculum to improve nurses' knowledge and skills,
(3) Implement a resource-cognizant, relevant, and effective neonatal nursing curriculum, and
(4) Assess changes in knowledge, skills, and confidence of curriculum participants.

Methods

Kern's Six Step Approach to Curriculum Development was used as a framework for curriculum development to develop and pilot implementation.[12]

Formation of a Collaborative, Multi-disciplinary, Representative Team of Project Champions

A diverse team of project champions was intentionally formed, consisting of Tanzanian hospital and US academic university nurses, charge nurses, neonatal nurse practitioner (NNP), clinical nurse specialist (CNS), pediatricians, and neonatologists to encompass a broad range of knowledge, skills, and experiences, including education/training, clinical practice, research, and advocacy.

Steps 1 and 2: Problem Identification and Needs Assessment

The team co-designed a formal focused educational needs assessment of 15 clinical topics and skills. The topics were selected based upon the clinical and educational expertise of the NNP and CNS. Tanzanian hospi

tal neonatal nursing staff and nursing leadership scored topics on importance and frequency of use in clinical nursing practice on a scale of one to three (one being least important/used; three being most important/used).

Step 3: Goals and Objectives

The results from the needs assessment were used to co-develop a ten-month curriculum that was resource-cognizant, relevant, and feasible for neonatal nurses in the Tanzanian hospital. The curriculum was built upon foundational knowledge emphasized in Tanzanian education for nurses and US education for certified neonatal nurses and nurse practitioners. Publications for educating novice neonatal nurses provided by professional neonatal nursing organizations were also consulted.[13] The team provided special attention to the didactic content to ensure these was relevant to resources available at the Tanzanian hospital. For example, central lines for medication and fluid administration were rarely used and parenteral nutrition and continuous suction was not available. Supplemental Table 1 contains the clinical topics and learning objectives of the curriculum.

Step 4: Educational Strategies

The curriculum was developed in a flipped classroom model with 20 pre-recorded lectures supplemented by both virtual and in-person discussion sessions, all in the English language. The flipped classroom format was selected to support adult learning theories[14] and infrastructure constraints at the Tanzanian hospital, including internet connectivity and bandwidth issues. The curriculum was accredited by a national association, Tanzania Nursing and Midwifery Council (TNMC), to provide participants with continuous professional development points and a sustainable local platform for the material.

Step 5: Implementation

The team piloted implementation of the curriculum in 2023 with an initial cohort of Tanzanian neonatal nursing staff and nursing leadership. Participation was found to vary throughout the curriculum. Written assessments in English with multiple choice questions were offered at scheduled time points, including pre-curriculum, midpoint, post-curriculum, and six-month retainment to address the first three levels of the Kirkpatrick Model of learning evaluation as part of a prospective cohort study, including bedside nurses and neonatal charge nurses.[15] The pre-curriculum, post-curriculum, and six-month retainment assessments contained the same knowledge questions. The midpoint assessment consisted of different knowledge questions from the other assessments.

At the midpoint of the curriculum, it was noted that attendance and participation during the discussion sessions were low. Discussions between participants and the team revealed high clinical workloads, internet connectivity issues, preference for didactics as the learning style, and cultural and hierarchical dynamics influencing public speaking. The team worked with nursing leadership on supporting nursing staff attendance, hospital leadership were informed of internet issues, sessions were reformatted to provide more didactic education, and participants were sent email and WhatsApp reminders prior to each session. The six-month retainment assessment was provided six months after the completion of the curriculum to determine knowledge retention and potential need for re-training or refresher modules. A curriculum evaluation was provided at the course's completion to gather information on the format, logistics, and hands-on skills of positive pressure ventilation (PPV) and peripheral intravenous catheter (PIV) placement and securement. Results were compiled in Microsoft Excel and analyzed using descriptive statistics and paired t-tests to determine significance.

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 2013.[16] Approval of the Tanzanian hospital and US academic university Institutional Review Boards were also obtained.

Results

Step 6: Evaluation and Feedback

The educational needs assessment was completed by 11 respondents, consisting of two nurse leaders and nine neonatal nursing staff (Table 1). They scored physical exam, respiratory system, and resuscitation as the most important topics (mean 2.8, SD 0.4). The most used topics were respiratory system (mean 3, SD 0), gestational age assessment (mean 2.9, SD 0.3), and physical exam (mean 2.8, SD 0.4).

Table 1: Needs Assessment Results (n=11)

Topic	Importance	Frequency of
	Mean (SD)	Mean (SD)
Neonatal Physical Exam	2.8 (0.4)	2.8 (0.4)
Respiratory System	2.8 (0.4)	3 (0)
Neonatal Resuscitation	2.8 (0.4)	2.8 (0.4)
Gastrointestinal Complications	2.7 (0.6)	2.6 (0.5)
Transition to Extrauterine Life	2.7 (0.5)	2.7 (0.6)
Gestational Age Assessment	2.7 (0.5)	2.9 (0.3)
Cardiovascular System	2.7 (0.5)	2.5 (0.8)
Hematologic Issues	2.7 (0.5)	2.8 (0.4)
Nutritional Support	2.6 (0.7)	2.7 (0.5)
Developmental Care & Pain	2.6 (0.5)	2.7 (0.5)
Neurological Complications	2.6 (0.5)	2.5 (0.5)
Simulation	2.6 (0.5)	2.7 (0.5)
Infectious Disease	2.5 (0.7)	2.5 (0.5)
Renal Issues	2.5 (0.5)	2.5 (0.5)
Pharmacology & Blood Transfusions	2.4 (0.8)	2.6 (0.5)

When comparing completion of the curriculum assessments, 12 neonatal nursing staff participants completed the pre-curriculum assessment, 15 participants com

completed the midpoint assessment, 11 participants completed the post-curriculum assessment, and 11 participants completed the six-month retainment assessment. Of note, six unique participants completed all four assessments with an average attendance of 68% of total sessions for those participants.

The pre-curriculum assessment revealed the topic intestinal complications had the highest percentage of questions correct and the cardiovascular system had the lowest (33%). One question was incorrectly answered by all 12 participants and was removed and not included in all subsequent assessments, otherwise answers on individual questions ranged from 8% to 100% correct.

The midpoint assessment revealed the topic gastrointestinal complications had the highest percentage of questions correct (73%) and neurological complications had the lowest (13%). As shown in Table 2, of the eight participants who completed both pre-curriculum and midpoint assessments, three had higher scores on the midpoint assessment than on the pre-curriculum assessment.

Table 2: Comparison of Pre-curriculum and Midpoint Assessment Results for Participants Completing Both (n=8)

Topic	Pre-curriculum Assessment Mean Percentage Correct (%)	Midpoint Assessment Mean Percentage Correct (%)	Percent Difference (%)
Neonatal Physical Exam	57.1	NA	NA
Transition to Extrauterine Life	NA	NA	NA
Gestational Age Assessment	NA	87.5	NA
Nutritional Support	65.6	NA	NA
Neurological Complications	NA	12.5	NA
Renal Issues	NA	NA	NA
Pharmacology & Blood Transfusions	87.5	NA	NA
Neonatal Resuscitation	72.5	NA	NA
Cardiovascular System	37.5	52.5	15
Developmental Care & Pain Management	72	80	8
Hematologic Issues	66.7	62.5	-4.2
Gastrointestinal Complications	93.8	81.3	-12.5
Respiratory System	79.2	64.6	-14.6
Infectious Disease	87.5	70	-17.5
Overall	72	67.4	-4.6

The post-curriculum assessment revealed the topic gastro intestinal complications had the highest percentage of questions correct (94%) and hematologic issues had the lowest (61%). Answers on individual questions ranging from 18% to 100% correct. As shown in Table 3, when comparing scores of the six participants who completed both pre-curriculum and post-curriculum assessments, five topics had higher scores and five topics were lower.

Table 3: Comparison of Pre-curriculum and Post-curriculum Assessment Results for Participants Completing Both (n=6)

Topic	Pre-Assessment Mean Percentage Correct (%)	Post– Assessment Mean Percentage Correct (%)	Percent Difference (%)
Cardiovascular System	50	83.3	+33.3
Nutritional Support	62.5	75	+12.5
Neonatal Resuscitation	70	80	+10
Gastrointestinal Complications	91.7	100	+8.3
Neonatal Physical Exam	57.1	64.3	+7.2
Developmental Care & Pain Management	73.3	66.7	-6.6
Hematologic Issues	66.7	55.6	-11.1
Infectious Disease	83.3	66.7	-16.6
Respiratory System	77.8	61.1	-16.7
Pharmacology & Blood Transfusions	100	83.3	-16.7
Overall	71.2	71.6	+0.4

The curriculum feedback offered at the completion of the curriculum resulted in ten participants (91%) stating 'yes' to learning a new technique to performing PPV and noticing a difference in the way they performed PPV. Regarding PIV placement, ten participants (91%) stated 'yes' to learning a new technique for PIV insertion and securement with all 11 participants noticing a difference in the way they placed PIVs. All 11 participants stated 'yes' to "Do you feel the knowledge and skills provided during the curriculum will continue in clinical practice?".

The six-month retainment assessment revealed the topic gastrointestinal complications had the highest percentage of questions correct (100%) and hematologic issues had the lowest (33%). As shown in Table 4, when comparing scores of the six participants who completed both pre-curriculum and six-month retainment assessments, five topics had higher scores, four topics had no change in scores, and one topic had lower scores, with an overall increase in knowledge (+7%).

Table 4: Comparison of Post-curriculum and Six-month Retainment Assessment Results for Participants Completing Both (n=6)

Topic	Post-Assessment Mean Percentage Correct (%)	6-month Retainment Assessment Mean Percentage Correct (%)	Percent Difference (%)
Hematologic Issues	55.6	77.8	+22.2
Pharmacology & Blood Transfusions	83.3	100	+16.7
Infectious Disease	66.7	83.3	+16.6
Nutritional Support	75	83.3	+8.3
Neonatal Physical Exam	64.3	66.7	+2.4
Developmental Care & Pain Management	66.7	66.7	0
Respiratory System	61.1	61.1	0
Gastrointestinal Complications	100	100	0
Neonatal Resuscitation	80	80	0
Cardiovascular System	83.3	66.7	-16.6
Overall	71.6	78.6	+7

Discussion

The continuing disparate high neonatal mortality rates in predominantly LMIC regions remains a global challenge.[1] The strengthening and capacity building of the global neonatal nursing workforce has been put forth as an integral part of the solution for improving neonatal mortality outcomes, especially in these high burden regions.[7] This project sought to improve the knowledge and skills of neonatal nurses at a Tanzanian hospital in a high burden region.

The educational needs assessment identified important and frequently used topics in clinical neonatal nursing practice to be included and emphasized in curriculum development. The pre-assessment data reinforced key gaps in participants' knowledge. The midpoint assessment data was used to modify the curriculum in a real-time manner. The post-curriculum assessment data demonstrated mixed changes in knowledge following completion of the curriculum. A six-month retainment assessment provided six months after the completion of the curriculum demonstrated an overall increase in knowledge, particularly in hematologic complications, pharmacology, blood transfusions, newborn resuscitation, infectious disease, nutritional support, and the newborn physical exam. Overall, the nurses had strong engagement and satisfaction with the curriculum and demonstrated some knowledge gains and self-perceived clinical behavior changes.

The first three levels (reaction, learning, impact/behavior) of the Kirkpatrick Model of learning evaluation were addressed with the assessments and curriculum feedback, as some knowledge gains and self-perceived clinical behavioral changes were described. These first three levels are easier to evaluate compared to the fourth level (clinical results).[17] The ultimate clinical outcome of neonatal mortality is multi-factorial, influenced by more than nursing care, and measuring this specific outcome for this project would not have accurately reflected any change in nurses' knowledge and skills. The evaluation of other clinical outcomes, such as PIV infiltrates, can be helpful to assess the higher levels of the Kirkpatrick Model and monitor changes in knowledge and skills in the future.

The strengths of this project include its initial conception as a self-identified need for a structured curriculum by nurses in the Neonatal Ward. The educational needs assessment was critical to ensuring that the specific learning needs of the unit were addressed and that the educators were adhering to local regulations and standards.[18] Additionally, national accreditation from TNMC provided credibility to the curriculum and an impetus for nurses to participate. The multidisciplinary team included two advanced practice nurse roles, such as a CNS and NNP, another strength of the project. The CNS works to implement evidence-based practices, coordinate research and quality improvement projects, provide expert consultation to enhance the provision of care, and improve patient outcomes by collaborating with the healthcare team and the system. NNPs are trained to make critical decisions and manage the diagnosis and treatment of neonatal conditions. The NNP often focuses on the medical management of the patient and the CNS impacts care across the patient, staff, and the system. Teamwork with the NNP and CNS can improve patient outcomes, enhance multidisciplinary relationships, and support a culture of lifelong learning in newborn care resulting in a holistic and synergistic approach.

Limitations of this project included a small study size, single institution, and different questions in pre-curriculum and midpoint assessments that may have had different difficulty levels that did not equally assess participants' knowledge. Potential reasons for the pre-curriculum and post-curriculum assessment comparative results include the assessment questions may not have fully evaluated participants' knowledge and high clinical workloads limited participant attendance at discussion sessions and assessments. The selected group was small and there had been discussions prior to implementation with nursing leadership to minimize work obligations to maximize participation, but this challenge has been noted in previous literature.[18]
Additionally, there was subjective concern for language barriers during implementation of the curriculum. During curriculum development there were discussions regarding which spoken and written language to use. The team decided to use English given this is the primary language used for formal higher-level education in Tanzania and within the Tanzanian hospital.

Implications for sustainability of this curriculum are greatly influenced by the nursing structure and buy-in by

stakeholders. Currently, the nurses are not currently dedicated to the neonatal role and therefore there is great potential for high turnover rates.[19,20,21] For this nursing education to continue, there will need to be an emphasis on either decreasing the turnover of nurses who have participated in the curriculum or developing a structured checklist and orientation path for newly graduated nurses and those transferring into the Neonatal Ward.

From this initial cohort, six master trainers were selected to streamline the curriculum topics and learning objectives and develop a checklist of bedside clinical skills to complement the educational curriculum. They will then proceed to expand the curriculum to the remainder of the nurses within the Neonatal Ward, other services at the Tanzanian hospital caring for newborns, and referring community sites in a train the trainer format. The expansion of this curriculum will also include evaluation of focused clinical outcomes, such as PIV infiltrates and unplanned extubations, within the Neonatal Ward.

This multi-disciplinary co-designed nationally accredited advanced neonatal curriculum provides the potential for improved quality of care for newborns through capacity building and strengthening of nurses.

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