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## A blended curriculum to improve student community health officers' competencies in newborn infection prevention and control

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### ABSTRACT

**Background:** Infections contribute significantly to neonatal mortality in Nigeria. Community health officers (CHOs) provide maternal, newborn and child health services at the primary health care level. However, newborn infection prevention and control (NB-IPC) is not included in their current training curriculum, which has little innovation in teaching methods. This study assessed the effectiveness of a blended curriculum on NB-IPC in improving the competencies of student CHOs.

**Methods:** This pre- and post-test study was conducted in the CHO training school of Lagos University Teaching Hospital (LUTH), which has 70 students enrolled. We developed and implemented a blended curriculum on NB-IPC using Kern's six-step framework. Twelve videos were recorded of content experts teaching various aspects of NB-IPC and were watched online or downloaded by students. Two interactive practical sessions were held in class. Pre- and post-course assessment of knowledge was with multiple choice questions, attitude with a Likert scale, and skills with an objective structured clinical examination (OSCE). Course satisfaction was also assessed with a validated scale. Paired *t*-test was used to determine mean differences at a significance level of 0.05.

**Results:** The mean knowledge score of students increased from 10.70 (95% confidence interval (CI): 10.15–11.24) pre-course out of a possible score of 20 to 13.25 (95%CI: 12.65–13.84) post-course ( $p < 0.001$ ). Mean attitude score increased from 63.99 (95%CI: 62.41–65.56) out of a possible score of 70 to 65.17 (95%CI: 63.68–66.67) ( $p = 0.222$ ). The mean OSCE score increased from 21.27 (95%CI: 20.20–22.34) out of a possible score of 58.5 to 34.73 (95%CI: 33.37–36.09) ( $p < 0.001$ ). Mean post-course satisfaction score of students was 127.84 (95%CI: 124.97–130.89) out of a possible score of 147.

**Conclusion:** The new curriculum on NB-IPC improved the competencies of student CHOs in LUTH and they were highly satisfied. The blended curriculum may be a feasible addition to learning in CHO schools across Nigeria.

### KEY MESSAGE

- A blended curriculum on NB-IPC involving video teaching is effective in improving the competencies of student CHOs

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## Introduction

Nigeria has an unacceptably high neonatal mortality rate. Of the 128 under-five deaths per 1000 live births documented during the 2013 Nigeria Demographic

and Health Survey (NDHS), 37 deaths per 1000 live births occurred in the neonatal period, a period crucial to the health, growth and development of children [1]. The trend in neonatal mortality did not reflect a

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decline in the 2018 NDHS, which was 38 deaths per 1000 live births [2]. As of 2020, the neonatal mortality rate was 35.46 deaths per 1000 and still fell significantly short of the Sustainable Development Goal (SDG) target of a minimum of 12 per 1000 live births by the year 2030 [3,4].

Infections are a major contributor to neonatal mortality in Nigeria, accounting for over 26% of newborn deaths [5]. A systematic review revealed incidence rates ranging from seven to 54.9/1000 live births in different states of the nation [6]. Neonates are more susceptible to infections because of their relatively low immune defense mechanism, which is exacerbated by prematurity [7]. The factors responsible for this include among others: low socioeconomic status, delivery outside of health facilities, poor maternal hygiene, prolonged rupture of amniotic membrane, nosocomial infections, poor identification of newborn infections and late presentation for care, as well as poor cord care practices like the use of cow dung, toothpaste, charcoal and warm rag application to the umbilical stump [8].

To promote newborn health and meet the SDG target, the national action plan recommends intervention packages such as the promotion of facility-based deliveries, strengthening of community-based interventions, strengthening facility readiness and provision of quality care for the newborn [5]. Providing quality care requires the empowerment of all cadre of healthcare workers through capacity building and support.

Community health workers (CHWs) can be taught to counsel mothers and care for them and their newborns in the community, assess for danger signs, and assist families in accessing clinical care when necessary [8]. The Community Health Officers (CHOs) are the more senior of the CHWs at the primary health care (PHC) level in Nigeria. They spend 30% of their time in the community, 70% of their time in primary health care centers, provide supervision for lower cadre Community Health Extension Workers and traditional birth attendants and are trained in teaching hospitals across Nigeria [9,10]. Essential newborn care is currently covered in the curriculum of CHOs. However, it does not lay a strong emphasis on infection prevention and control (IPC). The predominant teaching is on cord care with 4% chlorhexidine gel, warranting the need to improve knowledge and practices of CHOs in other aspects of learning such as the appropriate use of personal protective equipment, hand and environmental hygiene, waste management, diagnosis of newborn infections and appropriate management, and infection control messages to pregnant and newly delivered women [11]. Improving CHOs knowledge and skills in infection control and care of newborn would empower them to engage in best

practices and motivate them to effectively pass on infection control messages to caregivers, families and communities, which could ultimately result in reduced infection rates in neonates and reduced mortality.

Our study aims to assess the effectiveness of a blended newborn infection prevention and control (NB-IPC) curriculum involving video teaching in improving the knowledge, skills and attitudes of NB-IPC among student CHOs in southwest Nigeria. The study is relevant in the wake of high numbers of newborn deaths due to infections, and the current COVID-19 pandemic, which has led to a change in the traditional approach of medical education [12]. We pilot video teaching, which is innovative in the school, and sustainable as it does not always require internet connectivity, which can be costly and inconsistent in Nigeria.

## Methods

### *Study design and site*

We conducted a pre- and post-test study among student CHOs at the Community Health Officers training school of the Lagos University Teaching Hospital (LUTH). The school was started by the College of Medicine of the University of Lagos in 1979 as a one-year Diploma programme. However, the school was transferred to LUTH in 1989 and was adopted as one of its schools. In 2008, the Community Health Practitioners' Registration Board of Nigeria, changed the course to a two-year Higher Diploma course in Community Health. This two-year programme admits Community Health Extension Workers (CHEWs), who have done an abridged programme for Diploma in Community Health, as well as holders of Diploma in Community Health from the Schools and Colleges of Health Technology.

The school is situated at the LUTH Annex in Pakoto, Ogun State. Most of the activities during the training take place at the Primary Health Care Complex and villages, within a 10-kilometre radius, which serve as the practice area for primary health care activities. The school is charged with the responsibility of training health workers whose roles include community outreach activities, provision of integrated PHC services, administrative and training responsibilities in clinic and community settings. At the time of study, there were 36 students in the first year and 34 students in the second year. All 70 students were targeted for the study.

### *Data collection*

We assessed the students' baseline knowledge, attitude and skills on NB-IPC. Knowledge was assessed using a

20-item multiple choice question (MCQ) format with the choice of one best answer out of five. The MCQs were developed from the curriculum and their internal reliability after baseline data collection gave a Cronbach's alpha coefficient of 0.47. A 10-item attitude scale presented as a seven-point Likert scale (strongly disagree, disagree, somewhat disagree, neutral, somewhat agree, agree, strongly agree) was used to determine attitude towards NB-IPC. The third and ninth items were negatively worded and thus were reverse-scored. The scale was adapted from literature [13] and its internal reliability after baseline data collection gave a Cronbach's alpha coefficient of 0.84. A six-station objective structured clinical examination (OSCE) was conducted to determine skills in NB-IPC. These skills were identified from the curriculum and included examination of a newborn, demonstration of hand hygiene, counseling of caregiver on NB-IPC, waste management, donning and doffing of personal protective equipment and preparation of disinfecting solution.

The same tools were used after the implementation of the curriculum. In addition, post-course satisfaction was also assessed. The satisfaction scale presented as a seven-point Likert scale was adapted from a previously validated scale on domains regarding the instructor, technology, setup, interaction, outcomes, and overall satisfaction [14]. Its internal reliability after data collection gave a Cronbach's alpha coefficient of 0.92.

## **Intervention**

### **Curriculum development**

Using the Kern's six step approach to curriculum development [15,16], we developed a blended curriculum on NB-IPC for CHO students. The framework is described in more detail in the [supplementary table \(Appendix 1\)](#). The content of the curriculum was developed from an extensive literature review and the content was validated by content experts including IPC professionals, neonatologists, family medicine specialists, epidemiologists and CHO tutors. After content validation, 12 videos (including one introductory video) were recorded of content experts teaching various aspects of NB-IPC. All videos were uploaded onto YouTube for online viewing and Google Drive for downloading in a WhatsApp compatible version. They were also made available on compact discs and flash drives to allow for multiple ways to view the videos. Needs assessment had revealed a lack of central internet service in the school and an irregular power supply. The development of the NB-IPC curriculum has previously been described in a conference abstract [17].

A study guide was developed for the students which included learning objectives, three-course modules each with two units, links to the videos, additional readings, and assignments. The topics covered included: Identification of a normal newborn; Role of CHOs in newborn care; Source of infections in the newborn; Infection prevention and control: care of the newborn in the health facility; Standard precautions: hand hygiene and personal protective equipment; Environment of care in the health facility; Care of the newborn in the community; Environment of care in the community; Counseling on newborn infection to mothers and families; CHO's response to newborn infections; managing severe infections in the newborn and; Referral of a sick baby ([Table 1](#)). The two videos on managing severe infections in the newborn and referral of a sick baby were not recorded by the study team but sourced online from a healthcare video teaching repository [18].

### **Curriculum implementation**

Curriculum implementation lasted for a period of six weeks from August 1 to September 15, 2021. Students used the study guide and watched the videos through multiple means of access on their own time. They were instructed to complete one-course unit within one week. We had two days in-class practical sessions which covered demonstrations on required skills on NB-IPC as specified in their study guide. A dedicated e-mail allowed for questions and assignment submission, and a WhatsApp platform community of practice facilitated continued discussion about the course and its content.

### **Curriculum evaluation**

The outcomes of interest were improvement in knowledge, skills and attitudes, and students' satisfaction with the course. We also explored the course experience of the students. The first outcome was measured by comparing pre- and post-course assessment scores. The second outcome was measured as a post-course survey while the third exploratory outcome was assessed in a post-course focus group discussion (FGD) among 12 participants. We used a topic guide to collect data during the FGD, which was audio-recorded. All post-course data was collected immediately after curriculum implementation.

### **Data analysis**

Quantitative data were analyzed using STATA version 15 (Stata Corp, USA). Significant differences in pre- and post-course mean knowledge, OSCE and attitude

**Table 1.** Developed curriculum on newborn infection prevention and control.

Curriculum goal: To develop student community health officers' (CHOs) knowledge of, skills in and attitudes towards newborn infection prevention and control through a blended education program.

Module	Unit	Video topics	Practical session
1. Newborn and infections.	The healthy newborn.	<ul style="list-style-type: none"> <li>• Identification of a normal newborn.</li> <li>• Role of CHOs in newborn care.</li> </ul>	Demonstration of examination of a newborn in class using a newborn model.
	The problem of infections in the newborn.	<ul style="list-style-type: none"> <li>• Epidemiology of newborn infections.</li> <li>• Source of infections in the newborn.</li> </ul>	None
2. Prevention and control of infections in the newborn.	Prevention of newborn infections in the health facility.	<ul style="list-style-type: none"> <li>• Infection prevention and control: care of the newborn in the health facility.</li> <li>• Standard precautions: hand hygiene and personal protective equipment.</li> <li>• Environment of care in the health facility.</li> </ul>	<ul style="list-style-type: none"> <li>• Handwashing technique using soap and water and alcohol hand rub.</li> <li>• Donning and doffing of personal protective equipment.</li> <li>• Preparation of chlorine solution for disinfection.</li> <li>• Waste management.</li> </ul>
	Prevention of newborn infections in the community.	<ul style="list-style-type: none"> <li>• Care of the newborn in the community.</li> <li>• Environment of care in the community.</li> <li>• Counseling on newborn infection to mothers and families.</li> </ul>	<ul style="list-style-type: none"> <li>• Pair up with a class member and role play the care of a newborn during a postnatal visit to a mother at home.</li> <li>• Role-play of health education to community members on environmental hygiene to prevent newborn infections.</li> <li>• Pair up with a class member and role play a counseling session on newborn infection prevention to a mother or caregiver.</li> </ul>
3. Care of infections in the newborn.	Care of newborn infections by community health officers.	<ul style="list-style-type: none"> <li>• CHO's response to newborn infections.</li> <li>• Managing severe infections in the newborn.</li> </ul>	<ul style="list-style-type: none"> <li>• Pair up with a class member and role play response to newborn infection during a home visit with a mother of a newborn with signs of illness.</li> </ul>
	The referral process.	<ul style="list-style-type: none"> <li>• Referral of a sick baby.</li> </ul>	None

scores were evaluated using paired *t*-test. Level of significance was set at 5%. To determine the proportion of students with satisfactory skills before and after the course, we applied the cut-off mark of 45% to overall OSCE scores, which is typically used in the school as a pass for practical exams.

Mean course satisfaction scores were calculated for each item on the scale as well as the combined items in subscales.

The audio recording from the FGD was transcribed verbatim and thematic analysis was conducted using Braun and Clarke's six steps of thematic analysis (familiarity with the data, generation of initial codes, search for themes, review of themes, definition and naming of themes, and production of the report) [19]. We used an inductive approach in generating the codes manually.

### **Ethical considerations**

The study proposal was submitted to the Health Research and Ethics Committee of the Lagos University Teaching Hospital for review. The committee exempted the proposal from review and provided a letter of exemption from review (ADM/DCST/HREC/APP/4126). Free and informed verbal consent was obtained from participating students.

### **Results**

Sixty-nine students participated in both the pre- and post-course assessment of knowledge and attitude

while 63 students participated in both the pre- and post-course OSCE.

### **Effectiveness of curriculum in improving competencies of students**

The students showed statistically significant improvement in answering nine out of the 20 MCQs (questions 2, 4, 5, 6, 8, 12, 13, 19, 20). Overall, there was a statistically significant increase of mean knowledge score from 10.70 (95% confidence interval (CI): 10.15–11.24) pre-course out of a possible score of 20 (53.5%) to 13.25 (95% CI: 12.65–13.84) post-course (66.5%) [ $p < 0.001$ ] (Table 2).

The mean scores for each OSCE station increased significantly from pre- to post-course. Their overall mean OSCE score increased from 21.27 (95% CI: 20.20–22.34) out of a possible score of 58.5 (36.4%) to 34.73 (95% CI: 33.37–36.09) (59.3%) [ $p < 0.001$ ] (Table 3). Seven students (11.1%) had satisfactory skills in NB-IPC pre-course while 58 students (92.1%) had satisfactory skills post-course.

The mean scores for attitude statements 3, 5 and 8 increased significantly from pre- to post-course. The overall mean attitude score increased from 63.99 (95% CI: 62.41–65.56) out of a possible score of 70 (91.4%) to 65.17 (95% CI: 63.68–66.67) (93.1%). However, this was not statistically significant ( $p = 0.222$ ) (Table 4).

### **Course satisfaction of students**

Regarding the students' satisfaction with the course, the mean scores for the 21 items on the scale ranged from 5.74 to 6.29 (Table 5). Over 90% of the students

**Table 2.** Pre- and post-course knowledge of newborn infection prevention and control.

Questions and correct options	Pre-course (N=69)		Post-course (N=69)		p-value
	Frequency (%)	Mean score (95% CI)	Frequency (%)	Mean score (95% CI)	
1. What is the newborn period of a baby's life? <i>First 4 weeks.</i>	29 (42.03)	0.42 (0.30–0.54)	36 (52.17)	0.52 (0.40–0.64)	0.211
2. What makes newborn babies prone to infection? <i>Immature immune system.</i>	55 (79.71)	0.80 (0.70–0.89)	63 (91.30)	0.91 (0.84–0.98)	<b>0.045</b>
3. Which is a symptom of infection in a newborn baby? <i>Being very sleepy.</i>	5 (7.25)	0.07 (0.01–0.14)	9 (13.04)	0.13 (0.05–0.21)	0.251
4. What is the main source by which germs are transmitted to newborns at the health facility and at home? <i>Hands.</i>	48 (69.57)	0.70 (0.58–0.81)	59 (85.51)	0.86 (0.77–0.94)	<b>0.007</b>
5. Which infection can pass from the mother to the baby in the womb? <i>Rubella.</i>	15 (21.74)	0.22 (0.12–0.32)	35 (50.72)	0.51 (0.39–0.63)	<b>&lt;0.001</b>
6. Which infection can pass from the mother to the baby in the birth canal during delivery? <i>Conjunctivitis.</i>	18 (26.09)	0.26 (0.15–0.37)	29 (42.03)	0.42 (0.30–0.54)	<b>0.027</b>
7. What are standard precautions? <i>Work practices of infection prevention and control.</i>	24 (34.78)	0.35 (0.23–0.46)	34 (49.28)	0.49 (0.37–0.61)	0.077
8. At what point should hands be cleaned when caring for a newborn baby? <i>After touching the environment around a newborn.</i>	45 (65.22)	0.65 (0.54–0.77)	61 (88.41)	0.88 (0.81–0.96)	<b>0.001</b>
9. Which is a standard precaution in newborn care? <i>Sterilization of reusable instruments.</i>	27 (39.13)	0.39 (0.27–0.51)	32 (46.38)	0.46 (0.34–0.58)	0.278
10. In what way can hands get contaminated? <i>Environmental surfaces.</i>	63 (91.30)	0.91 (0.84–0.98)	67 (97.10)	0.97 (0.93–1.01)	0.159
11. What can be done to prevent infection of wounds/incisions? <i>Single use of medical devices.</i>	63 (91.30)	0.91 (0.84–0.98)	59 (85.51)	0.86 (0.77–0.94)	0.251
12. What is a possible cause of bloodborne infections? <i>Contaminated needles.</i>	38 (55.07)	0.55 (0.43–0.67)	50 (72.46)	0.72 (0.62–0.83)	<b>0.018</b>
13. What is a good way to disinfect water for general care of the newborn? <i>Put chlorine in the water for at least 30 min.</i>	26 (37.68)	0.38 (0.26–0.49)	42 (60.87)	0.61 (0.49–0.73)	<b>0.004</b>
14. What is a way to prevent newborn infections in the health facility? <i>Judicious use of antibiotics.</i>	26 (37.68)	0.38 (0.26–0.49)	30 (43.48)	0.43 (0.31–0.55)	0.418
15. What should be applied to the newborn's umbilical cord to prevent infection? <i>Chlorhexidine gel.</i>	67 (97.10)	0.97 (0.93–1.01)	69 (100.00)	1.00	0.159
16. What activity is most important within the first hour of a newborn's life? <i>Initiate breastfeeding.</i>	50 (72.46)	0.72 (0.62–0.83)	42 (60.87)	0.61 (0.49–0.73)	0.103
17. Which is a non-infectious health care waste? <i>Paper.</i>	58 (84.06)	0.84 (0.75–0.93)	64 (92.75)	0.93 (0.86–0.99)	0.083
18. What is the correct order for household water treatment? <i>Source protection, sedimentation, filtration, disinfection, safe storage.</i>	22 (31.88)	0.32 (0.21–0.43)	29 (42.03)	0.42 (0.30–0.54)	0.211
19. What is the correct order of putting on personal protective equipment? <i>Hand hygiene, put on apron, put on mask, put on gloves.</i>	20 (28.99)	0.29 (0.18–0.40)	47 (68.12)	0.68 (0.57–0.79)	<b>&lt;0.001</b>
20. What is the correct order of removing personal protective equipment? <i>Remove gloves, remove apron, remove mask, hand hygiene.</i>	39 (56.52)	0.56 (0.45–0.69)	57 (82.61)	0.83 (0.73–0.92)	<b>&lt;0.001</b>
Overall Knowledge Mean knowledge score %		10.70 (10.15–11.24) 53.5%		13.25 (12.65–13.84) 66.5%	<b>&lt;0.001</b>

CI: Confidence Interval.

agreed or strongly agreed with item 1 (94.2%), item 3 (91.31%) and item 14 (91.3%). Less than 80% of them agreed or strongly agreed to item 6 (71.02%), item 16 (79.71%) and item 19 (69.57%). The mean score % for the sub-scales ranged from 84.50% for technology to 88.68% for the instructor (Table 6).

### Course experience of students

Themes that emerged from the post-course focus group discussion were as follows:

Theme 1: Perception of the content of the videos.

The participants reported that the videos were educative, interactive, interesting, precise and innovative. There was also the consensus that the content of the videos was relevant and essential teaching needed for the daily delivery of their CHO roles at health facilities and communities. The demonstrations in some of the videos were considered illustrative and helped to improve knowledge and skills in NB-IPC (Table 7).

Theme 2: Motivation for video learning.

According to the participants, they were motivated to watch the videos because of their desire to know more and acquire more skills for their profession. Also, the

**Table 3.** Pre- and post-course skills in newborn infection prevention and control.

OSCE stations	Pre-course (N=63)	Post-course (N=63)	p-value
	Mean score (95% CI)	Mean score (95% CI)	
1. Handwashing	4.28 (4.07-4.49)	5.08 (4.80-5.35)	<0.001
2. Counseling on Newborn Infection Prevention to Mothers	4.53 (4.03-5.04)	6.87 (6.28-7.47)	<0.001
3. Disinfection	2.44 (2.11-2.78)	8.28 (7.55-9.00)	<0.001
4. Examination of the newborn	5.43 (4.86-6.00)	7.52 (6.97-8.06)	<0.001
5. Waste Management	2.35 (2.13-2.57)	2.94 (2.88-2.99)	<0.001
6. Donning and doffing of PPE	2.34 (2.00-2.48)	4.05 (3.81-4.28)	<0.001
Overall skill	21.27 (20.20-22.34)	34.73 (33.37-36.09)	<0.001
Mean score %	36.4%	59.3%	

CI: Confidence Interval.

convenience in watching the videos, the expertise of, diversity of and accessibility to the teachers, as well as the topics covered helped the students to develop an interest in video learning (Table 7).

Theme 3: Satisfaction with the course.

The students reported that they were satisfied with the content, facilitators, and the duration of the video teachings. They all rated their satisfaction highly on personalized scales. The reasons given for satisfaction with the course included: clarity of the content, improved knowledge and skills, convenience, and the ability to recommend and share the videos with others (Table 7).

Theme 4: Challenges experienced during the course.

The participants discussed the problems they had during the time they were learning from the videos. They complained about data consumption, time taken to download the videos, poor electricity, and inadequate labelling of video links. One participant

**Table 4.** Pre- and post-course attitude towards newborn infection prevention and control.

Statements	Pre-course (N=69)	Post-course (N=69)	p-value
	Mean score (95% CI)	Mean score (95% CI)	
1. It is important to prevent infections in the newborn.	6.83 (6.64-7.01)	6.78 (6.55-7.01)	0.763
2. I am concerned about infections in the newborn.	6.43 (6.16-6.70)	6.52 (6.28-6.76)	0.594
3. I do not have to wash my hands if I use gloves.	6.16 (5.85-6.47)	6.55 (6.33-6.77)	<b>0.044</b>
4. Guidelines on newborn infection prevention control should be adhered to at all times.	6.61 (6.35-6.86)	6.59 (6.36-6.83)	0.911
5. I have enough knowledge on newborn infection prevention and control.	5.39 (5.07-5.71)	6.00 (5.68-6.32)	<b>0.003</b>
6. I should attend in-service training/workshop related to newborn infection prevention and control regularly.	6.55 (6.33-6.77)	6.54 (6.29-6.78)	0.919
7. I should wash my hands before and after touching newborn babies.	6.64 (6.44-6.84)	6.67 (6.47-6.87)	0.831
8. I feel confident in my ability to counsel mothers and caregivers on newborn infection prevention.	6.19 (5.95-6.42)	6.55 (6.41-6.69)	<b>0.003</b>
9. Newborn infection prevention and control is not my responsibility.	6.51 (6.28-6.73)	6.42 (6.11-6.74)	0.639
10. Training on newborn infection prevention and control is relevant to my work practice.	6.78 (6.59-6.97)	6.55 (6.31-6.79)	0.117
Overall attitude	63.99 (62.41-65.56)	65.17 (63.68-66.67)	0.222
Mean attitude score %	91.4%	93.1%	

CI: Confidence Interval.

**Table 5.** Course satisfaction scores of students (n=69).

Item	Mean score (95% CI)
1. Class assignments were clearly communicated to me during the video learning.	6.29 (6.15-6.43)
2. Feedback and other assignments were given in a timely manner during the video learning.	6.14 (6.00-6.29)
3. The instructor makes me feel that I am part of the video learning class and belong.	6.12 (5.89-6.34)
4. I am satisfied with the accessibility and availability of the instructor during my video learning.	6.23 (6.06-6.41)
5. I am satisfied with how I am able to navigate within the video learning modules.	6.06 (5.84-6.27)
6. I am satisfied with download times of the videos for learning.	5.74 (5.46-6.01)
7. I am satisfied with the frequency I have to watch the videos.	6.12 (5.88-6.35)
8. I am satisfied with the flexibility this video learning affords me.	5.96 (5.59-6.32)
9. I am satisfied with the level of self-directedness I am given in this video learning.	6.06 (5.84-6.27)
10. I am satisfied with how much I enjoy working on the video learning by myself.	6.22 (6.02-6.41)
11. I am satisfied with the quality of interaction between all involved parties during the video learning.	6.17 (5.98-6.37)
12. I am satisfied with the process of collaboration activities during the video learning.	6.26 (6.10-6.42)
13. I am satisfied with how much I could relate to the other students during the video learning.	5.88 (5.60-6.17)
14. I am satisfied with how comfortable with participating I became.	6.28 (6.13-6.42)
15. I am satisfied with the level of effort this video learning course required.	5.97 (5.62-6.31)
16. I am satisfied with my performance in this video learning course.	5.93 (5.64-6.21)
17. I am satisfied with how I am able to apply what I have learned in this video learning course.	6.26 (6.07-6.45)
18. I am satisfied enough with this video learning course and can recommend it to others.	6.20 (6.01-6.39)
19. Compared to other course settings, I am more satisfied with this video learning experience.	5.77 (5.50-6.04)
20. My level of satisfaction in this video learning course would encourage me to enroll in another course in this setting.	5.96 (5.66-6.25)
21. Overall, I am satisfied with this video learning course.	6.23 (6.01-6.45)

CI: Confidence Interval.

complained about the inability to get instructor feedback while watching the videos (Table 7).

Theme 5: Recommendations for course improvement.

**Table 6.** Mean course satisfaction scores according to subscales.

Subscales	Mean score (95% CI)	Mean score %
Instructor (Items 1 – 4)	24.78 (24.26–25.30)	88.68
Technology (Items 5 – 6)	11.79 (11.38–12.22)	84.50
Set-up (Items 7 – 10)	24.35 (23.52–25.18)	87.07
Interaction (Items 11 – 14)	24.59 (23.97–25.22)	87.89
Outcome (Items 15 – 17)	18.16 (17.47–18.84)	86.48
Overall (Items 18 – 21)	24.16 (23.33–24.99)	86.29
Total satisfaction score (Items 1 – 21)	127.84 (124.97–130.89)	87.05

CI: Confidence Interval.

**Table 7.** Illustrative quotes for themes.

Theme 1 - Perception of content of the videos.

*'It's educative, it's interactive and it was as if am in class with the lecturer.'* (Participant 1, year one)

*'The video is short and precise! The message they were trying to pass across is very clear and the facilitators are very accessible.'* (Participant 11, year one)

*'The way the lecture has been presented in the video is very interesting to the extent that it has add(ed) a lot of knowledge to me. It has improved my skill because there were a lot of things we learnt. The way we are doing it before is quite different from what we saw on the video.'* (Participant 12, year two)

*'At my leisure time, I go back to watch the video again, watch again and see the procedures, especially that area of hand washing that the lecturer was carrying out the procedure practically... it was good. The lecturer was demonstrating the procedure of normal hand wash as if it was real.'* (Participant 5, year one)

Theme 2 - Motivation for video learning.

*'What really motivated me was that I wanted to know more. I wanted to go into it and know more about the lecture. That's what really motivated me and I know that going through it can...it is always available for me to go back and watch and watch and watch again, so that's what really motivated me.'* (Participant 3, year one)

*'The facilitators made me to be interested in the videos because whenever I'm going back to watch the video... I'm happy that they said if we have any challenge we can call them, chat with them privately...they will answer us. They do everything that motivated me on that video.'* (Participant 3, year one)

*'The people that taught us in the video and the content of the video were taken by different lecturers.'* (Participant 6, year two)

*'The kind of topics that they brought on board I knew is something that every health worker or anybody working in health line should know, I wanted to know more about the topic and after knowing more, it will help boost my self-confidence and self-esteem. I know for sure that doctors from LUTH came down to train us how to prevent infection in newborn and then I won't be scared of anything like infection, if I come across any infection in newborn. That was my motivation.'* (Participant 9, year two)

Theme 3: Satisfaction with the course.

*'Very satisfied... I'll say 95 percent! I can recommend the video for someone else because it is very educative, it serves the purpose of the education and is very interactive. It brings about the passion of the teacher and people can learn a lot from it.'* (Participant 2, year one)

*'Well on a scale of 1-10, I will give it 8 over 10 because I can always learn at my own convenient time.'* (Participant 5, year one)

*'Very, very (satisfied)... at least 80/85 percent! Because it is very well explanatory.'* (Participant 8, year two)

*'Eeeerh...I give 99.9 percent! Yeeees! I can recommend it in which I've done already.... So I sent it to my boss and she was so happy that something like that is coming up in our...in our profession because we're trying to....to project our profession in a...in a such a way that people will know that these people, these people are coming up!'* (Participant 6, year two)

Theme 4: Challenges experienced during the course.

*'It is data consuming. When I started it was consuming my data, in fact I had to buy another one (data) before I realized that we should... maybe I should download and all of that. Then I was having challenge with memory like it cannot download. I have to watch it online, and it was data consuming.'* (Participant 1, year one)

*'The constraints where those links were not well-labelled also when there was no light (electricity).'* (Participant 7, year two)

*'It was effective but the only constraint I had is that there was no network for downloading ..... I had to collect from my colleagues through Bluetooth on my laptop, so after that, I didn't have any problem.'* (Participant 8, year two)

*'The lecturer would not be able to give you the feedback at the time (of watching videos)... So, it will be later before we receive feedback.'* (Participant 4, year two)

Theme 5: Recommendations for course improvement.

*'This one (videos) they did now is self-explanatory but more of it should be more communicated in practical form..... that's what I'm talking about, the practical issue, that it should be more of practical.'* (Participant 5, year one)

*'Another improvement that we want to see in the next video teaching is that the next one should be more of pictures of those infections in babies.'* (Participant 12, year two)

*'All other courses should be introduced into video learning because we all know this is an adult school and many of our people... many of our students...they are civil servants. The video learning can help many of them.'* (Participant 6, year two)

*'I don't know maybe the school management or government can also help in subsidizing for data fee like providing Wi-Fi for us at a reduced fee, so that we'll not be spending too much after paying school fees and still be spending too much money on data.'* (Participant 10, year two)

The students recommended that the videos should contain more practical content and illustrative pictures. They suggested that the school authority should incorporate video learning in their other courses and make provision for internet service in the school (Table 7).

## Discussion

In this paper, we report on the evaluation of the effectiveness of a newly developed blended curriculum on NB-IPC for student CHOs. Our results demonstrate the effectiveness of the new curriculum, largely based on video teaching, in improving the competencies of student CHOs. It also demonstrates a high level of course satisfaction among the students.

### **Course design and methods**

We used blended learning as an innovative approach in the CHO school. The effectiveness of the use of videos in learning is encouraging as the benefits of video to both teachers and learners are evident, and the changing landscape in medical education including flipped classrooms and blended learning makes way for greater use of videos in learning [20]. Our findings support the current evidence that using videos enables cognitive learning and the gain of clinical skills in medical education in high- and low-income settings [21,22]. It is comparable to traditional means of training community health workers in terms of knowledge acquisition [23]. The use of different forms of videos had comparable effects to text-based resources on knowledge gain, knowledge retention and perception of medical students [24]. It outperformed traditional means in improving practical skills in infection prevention and control among Emergency Medicine residents [25]. The FGD with the student CHOs in this study also supported the quantifiable gain in knowledge and skills.

The flexibility and convenience of asynchronous technology-driven learning are attractive to learners [26]. Videos are particularly advantageous to student CHOs who are learning while also providing health care within communities. Being able to repeatedly watch the videos in a self-paced manner was appealing to them, as indicated in our evaluation of their course experience. Overall, the students had positive perceptions about video learning, similar to university students in Ghana [27].

We purposely granted multiple means of access to the videos in our study since we considered that in our context, students may not always have adequate access to the Internet or appropriate technology. Indeed, some challenges identified by the students who underwent this course were mainly related to technology. These considerations are important in the light of recommendations to adapt curricula to context for the proper education of health care professionals [28].

### **Course satisfaction**

Overall, course satisfaction was high both from the survey and the FGD. The subscale with the lowest score was technology, which is not surprising given the highlighted challenges. The subscale with the highest score was the instructor subscale. This is similar to the findings in the study that validated the satisfaction scale [14]. It appears that the students were mostly

satisfied with the clear communication of assignments from their study guide and access to instructors during blended learning and through the WhatsApp community of practice set up during the course. The role of the instructor has been shown to influence student satisfaction [29,30]. Students in online courses have valued constructive and timely feedback from instructors, instructors' positive attitudes to technology, instructor-student interaction and the social presence of the instructor [31,32]. The high level of satisfaction was also supported during discussions with the students and it revealed more in-depth reasons for course satisfaction including the quality of course content. Student-content interaction was found to be the most influential predictor of satisfaction in a recent study during COVID-19 [33].

### **Implications of curriculum effectiveness**

The implications of an effective blended curriculum on NB-IPC for CHOs are diverse. The COVID-19 pandemic has triggered the introduction of new methods of learning with videos being one of the feasible options in low- and middle-income countries [34,35]. Beyond the training in school, the videos remain an easily accessible source of learning on NB-IPC during healthcare practice within communities and health facilities especially where consistent supervision and continuing education are inadequate [36]. Continued training of CHWs is important if they are to remain relevant as community change agents [37]. From the FGD, it was clear that the students were motivated to learn the topic of NB-IPC because they perceived it to be important to their work. Prior to COVID-19, almost all 421 healthcare workers in a study in Nigeria expressed training needs for IPC [38]. Although the pandemic has put a spotlight on IPC training for healthcare workers, it has been in a general context largely to prevent the spread of COVID-19 [39]. The curriculum is thus filling an important gap in competencies in newborn care with the potential to improve the indices of newborn health. In this study, the students also shared the videos with colleagues outside of their school, which potentiates a greater pool of CHWs trained in NB-IPC offering hope for better healthcare for newborns and better communication on newborn care to caregivers and communities.

### **Curriculum scale-up**

To augment the competencies of newborn care in the existing curriculum, efforts to integrate the curriculum

with the existing essential newborn care training should be considered for holistic, sustainable learning. The student CHOs indicated their preference for more practical demonstrations in the videos in addition to the in-class practical sessions. This is an important consideration when scaling up the curriculum. More innovation is required to improve the process. For instance, procedural videos can be as effective as face-to-face demonstrations in teaching tasks [40] and can be incorporated in more ways than currently exist in our NB-IPC curriculum. Also, the use of interactive videos would help address some of the concerns regarding feedback since an important drawback of video teaching is the inability of students to fully interact with the medium [41]. Quizzes from frequently asked questions from this pilot could be incorporated into improvised videos at scale-up.

### Strengths

- To the best of our knowledge, this is the first study to evaluate the effectiveness of a newly developed blended curriculum on NB-IPC on the competencies of student CHOs.
- In addition, it assessed course satisfaction with a validated scale and used mixed methods for course evaluation.
- We used a total sample of the students in the school thus eliminating sample error.

### Limitations

- The duration of the course had to conform to the end of the academic session of the students and this might not have given all students ample time for learning before course evaluation.
- We did not assess the frequency or attention with which students watched the videos, which could have influenced their performance on the course. Evaluation tools such as learning analytics exist, which can measure learner attention by analyzing audience usage data on video-sharing platforms [42].
- Another limitation to consider is the lack of a comparison group with which to compare outcomes in our study design.

Despite these limitations, our evaluation demonstrates the clear benefits of the blended NB-IPC curriculum using quantitative and qualitative research methods. We have highlighted strategies, opportunities and challenges to consider for researchers and other

stakeholders in health professions education with an interest in similar work, or in a similar context.

### Conclusion

Our study provides useful insight into the assessment of the effectiveness of an innovative blended learning curriculum for student CHOs in improving competencies in the prevention and control of newborn infections, which is a significant public health problem in Nigeria. The curriculum on NB-IPC increased the knowledge and skills of student CHOs in LUTH significantly. Improvement in attitude was not statistically significant, however, the mean attitude score was very high. Students also showed a high level of satisfaction with the blended curriculum. Our findings have some practice and research implications. The blended curriculum may be a feasible addition to learning in CHO schools across Nigeria. We suggest the integration of innovative learning methods into their training. The inclusion of other cadre of CHWs, such as community health extension workers and volunteer CHWs, would positively influence capacity in NB-IPC. Future research can assess curriculum effectiveness and the processes of scale-up to other schools training CHOs and other CHWs with adaptations based on context. We suggest the use of comparison groups in such research to generate stronger research evidence. Furthermore, in scaling up the curriculum, sufficient attention should be given to the challenges and recommendations highlighted by students in this study. Evaluation of NB-IPC knowledge and skill retention of CHOs, particularly while working in health facilities and communities, is also suggested for future research.

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### Authors' contributions

MB, DS, AO, OA and FO were involved in the conception of the study. MB, BA, DS, VY, AO, RU, CE, OA and FO were involved in the design and administration of the study. MB, BA, DS, VY were involved in data analysis and interpretation.

MB wrote the first draft of the paper. BA, DS, VY, AO, RU, CE, OA and FO critically revised the paper for intellectual content. All authors approved of the final version and agree to be accountable for all aspects of the work.

## Disclosure statement

Anthonia Onyenwenyi, one of the authors, is a former head of the CHO school used in this study. Another author, Roseline Udeh, is the current head of the CHO school.

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## Data availability statement

The data that support the findings of this study are available on request from the corresponding author, MB. The data are not publicly available due to their containing information that could compromise the privacy of research participants.

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