Rwanda Medical Journal RMJ

Original research Open access

Continuous Positive Airway Pressure (CPAP) use in Rwanda compared to the TRY-CPAP algorithm - a retrospective descriptive study

Authors: E. Sibomana[1]; R. Ndayizeye[1]; I. Nyaziyose[1]; C. Conard[2,4]; P. Cartledge[2,4]

Affiliations: *[1]University of Rwanda; [2]University Teaching Hospital of Butare; [3]University Teaching Hospital of Kigali, [4]Yale University, Rwanda Human Resources for Health (HRH) Program, Rwanda*

ABSTRACT

INTRODUCTION: The TRY-CPAP algorithm was designed in Malawi to guide medical and non-medical healthcare professionals (HCPs) in decision making regarding which neonates should be managed with CPAP [1]. TRY-CPAP stands for "T: Tone is good, R: Respiratory Distress (sats <90% in 1l O_2) and Y=Yes (HR>100)". The TRY-CPAP algorithm supports not giving CPAP to neonates less than 1kg or those with poor tone (reflecting hypoxic-ischemic encephalopathy (HIE)), because of poor anticipated outcomes.
AIM: The aim of this descriptive research project was to evaluate baseline data on the outcomes of neonates within each of the five TRY CPAP groups.
METHODS: A retrospective, descriptive study was conducted at neonatology units at a referral hospital (CHUK) and a district hospital (Muhima, MDH). A retrospective file review was undertaken of included neonates using a non-printed questionnaire. 178 neonates were enrolled.
RESULTS: Oxygen was used in 74% of neonates and CPAP used in 43% of neonates. When CPAP was used, the mean duration was 3.8 days. 71% of neonates were found to have been allocated to CPAP in a manner concordant with the TRY-CPAP algorithm.
DISCUSSION: The TRY-CPAP algorithm could be appropriate for rationing CPAP in neonatology units in Rwanda. However, further work is required to identify appropriate thresholds for each treatment group prior to implementation in the Rwandan context.

Keywords (MeSH): Continuous Positive Airway Pressure; Infant; newborn; infant mortality; Intensive Care Units, Neonatal; Africa; Rwanda

INTRODUCTION

Neonatal respiratory distress is a common complication of premature birth [1]. In resource-rich settings, ventilatory support, such as mechanical ventilation, is available for the support of neonates with significant respiratory distress. However, mechanical ventilation is not available in most resource-limited settings because it is expensive and technically challenging [2], [3]. Continuous Positive Airway Pressure (CPAP) is the primary - alternative to mechanichal ventilation. Evidence has now accumulated to make CPAP the first-line treatment of respiratory distress in developing countries [1], [4]–[6]. Bubble (bCPAP) and flow-driver (FD-CPAP) have been shown to be equally effective in the resource-limited setting [7]. It is cost-effective, and with minimal training, CPAP can be applied by nurses and other health care providers [8]. "Home-made" CPAP can be achieved with relatively simple equipment using modified nasal prongs [4].

Corresponding author: Dr Peter Cartledge, peterthomascartledge@gmail.com; **Potential Conflicts of Interest (CoI):** All authors: no potential conflicts of interest disclosed; **Funding**: All authors: no funding was disclosed; **Academic Integrity**. All authors confirm that they have made substantial academic contributions to this manuscript as defined by the ICMJE; **Ethics of human subject participation:** The study was approved by the local Institutional Review Board. Informed consent was sought and gained where applicable; **Originality:** All authors: this manuscript is original has not been published elsewhere; **Type-editor**: Matthew Cardillo (USA)
Review: This manuscript was peer-reviewed by 3 reviewers in a double-blind review process;
Received: 18th December 2017; **Initial decision given**: 15th February 2018; **Revised manuscript received**: 15th May 2018; **Accepted**: 22nd June 2018

 Publisher: Rwanda Biomedical Centre (RBC)/Rwanda Health Communication Center, P.O.Box 4586, Kigali. ISSN: 2079-097X
Website: www.rwandamedicaljournal.org

The accurate identification of neonates who could benefit the most from CPAP remains a challenge. Early CPAP, ideally in the delivery room, for the right neonates can reduce the need for surfactant and/or ventilation [9]. However, CPAP is not an unlimited resource in many settings and neonates receiving CPAP require additional monitoring; therefore, its use needs to be prioritized for those neonates who are most likely to benefit. The Rwandan Ministry of Health (MoH) national neonatal care protocol gives indications for CPAP of: i. Term newborn with a moderate to severe respiratory distress; ii. very preterm (< 33 weeks gestation) or LBW newborns < 2 kg with any respiratory distress OR iii. Significant apnea and bradycardia of prematurity [10]. These protocols are relatively non-specific and may not adequately triage neonates to CPAP where the resource is scarce. This protocol was assessed in 3 Rwandan rural district hospitals for category ii (i.e. <33weeks and <1.5kg) neonates for adherence to the protocol [11]. Of bCPAP-eligible infants, only 49 (59.0 %) were correctly identified by health providers and 43 (51.8 %) were correctly initiated on bCPAP. For the 52 infants who were not bCPAP-eligible, 45 (86.5 %) were correctly identified as not bCPAP-eligible, and 46 (88.5 %) did not receive bCPAP [11]. Therefore a more robust system may be required. CPAP is also not a "silver-bullet" and is associated with adverse events such as facial trauma, air leak etc, therefore triaging infants less likely to require CPAP could potentially help to reduce these complications.

The TRY-CPAP algorithm (Figure 1) was designed in Malawi to guide healthcare professionals (HCPs) and non-medical personnel in decision-making regarding which neonates should be managed with CPAP [1]. The TRY-CPAP mnemonic represents: "T - Tone is good; R -Respiratory Distress (sats <90% on 1 liter of O_2); and Y=Yes (HR>100)." Poor tone is used as an indicator of Hypoxic-Ischemic Encephalopathy (HIE) and is a contraindication to CPAP in the algorithm. As the algorithm is used to identify the neonates most likely to benefit from CPAP, a weight cut off of 1kg is used, with neonates <1kg not receiving CPAP due to the poor prognosis in this group of neonates in this setting. The study was performed at Queen Elizabeth Central Hospital, Blantyre, Malawi a pediatric teaching site similar to our site [1]. The TRY-CPAP algorithm can be used by nurses in settings where clinicians are not always available and supports other studies which have shown that nurses can be trained to make decisions regarding the use of CPAP The authors did acknowledge that the algorithm was limited as it had not been tested in the district setting.

TRY-CPAP groups: The following are the TRY-CPAP groups, and the algorithm is further highlighted in **Figure 1:**

Group 1. Neonates 1-1.3kg (reflecting gestation ≤30 weeks) = Early CPAP

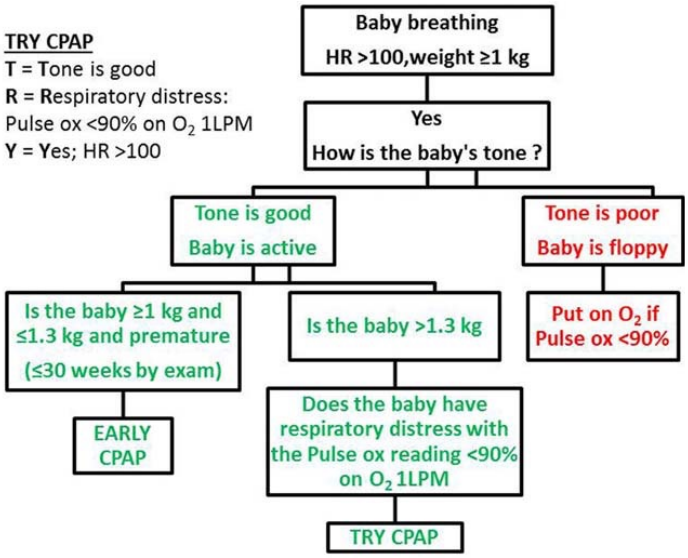
Group 2. Neonates >1.3kg (reflecting gestation >30 weeks) with respiratory distress (oxygen sat. of <90% on 1L Oxygen) = TRY CPAP

Group 3. Neonates >1.3kg (reflecting gestation >30 weeks) without respiratory distress (oxygen sat. of >90% on 1L Oxygen) = no CPAP (supportive care only)

Group 4. Poor tone (reflecting severe HIE) = no CPAP (supportive care only)

Group 5. Neonates <1kg = no CPAP (supportive care only)

Figure 1: TRY-CPAP alogrithm [1]



Objective: The TRY-CPAP algorithm has not been implemented in Rwanda. The aim of this descriptive study is to evaluate baseline data on the use of CPAP in two sites, the use of CPAP in each of the five TRY-CPAP groups, and whether HCPs are allocating neonates to CPAP in a similar manner to the TRY-CPAP protocol.

METHODS

Reporting of the current study proposal has been verified in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) checklist [12].

Study design: A retrospective, descriptive study (chart review) was conducted at the neonatal units of a referral hospital (University Teaching Hospital of Kigali (CHUK)) and a district hospital (Muhima District Hospital (MDH)). Both sites are located in Kigali, the capital city of Rwanda. CHUK is the largest, tertiary care, referral hospital in Rwanda, where it also serves as a teaching hospital for the University of Rwanda. MDH is a district hospital specializing in obstetrics, gynecology and neonatology (15). CHUK and MDH are "twin" sites sharing hospital management structures, but are located in different areas of the city and only CHUK is a referral center.

Population: This study involved neonates admitted to CHUK and Muhima District Hospital neonatal units from 1 January 2016 retrospectively until the sample size was complete. Inclusion criteria were neonates born on the site where neonatal care was provided. Included neonates were recruited into five groups as defined by the TRY-CPAP algorithm (Figure 2). Neonates who were admitted from home or ER were excluded.

Sampling: Infants were identified from the neonatal unit admission diary. Convenience/opportunistic sampling was employed to enroll neonates admitted to the neonatal unit at

CHUK and MDH between January 2015 – May 2017. Sampling and data collection was undertaken while undertaking a parallel project on antibiotic stewardship.

Outcomes: Demographics (gestation, gender, etc.) and basic clinical information (diagnosis, presence of respiratory distress etc.) were collected. Primary outcomes were the use of CPAP and/or oxygen use at any point during the admission and final disposition (discharge or mortality). Secondary outcomes such as the number of days of CPAP use were assessed where data was available from the case file.

Data Management and analysis: Obstetrical records were retrieved from the delivery sheet, documented by the nurse who conducted labor and all Neonates' data were recorded from a neonatology file. A case-file review was undertaken of included neonates using a non-printed questionnaire in Microsoft Excel. All data was analyzed electronically using SPSS. The objectives of this study were purely descriptive and therefore no comparative analysis was performed.

Ethics: Risks were assessed and felt to be minimal. No patient identifiable data was collected or stored. Data was kept in a password protected spreadsheet. The study protocol was reviewed and approved by the CHUK/MDH Ethics Committee (Ref: EC/CHUK/299/2017).

RESULTS

178 patients were included in the study with mean gestational age of 33.4 weeks (Table 1). Mean birth weight was 2.0 kg. 89.6% of mother received at least one antenatal visit. 53.9% of neonates had either mild or moderate respiratory distress at birth. Mean length of stay (LOS) was 28.1 days, with a longer LOS at Muhima. Mortality rate was 42%, with a much higher percentage dying at CHUK than at Muhima DH (63.4% vs. 29.5%, respectively).

Oxygen was used in 74% of neonates (Table 2) and CPAP used in 43% of neonates. When CPAP was used, the mean duration was 3.8 days. 71% of neonates were found to have been allocated to CPAP in a manner concordant with the TRY-CPAP algorithm this concordance was observed in 100% of neonates in group 1 and 70% in group 2 (Table 3). Groups 3, 4 & 5 should not receive CPAP and 88/128 (68%) correctly were not given CPAP (Table 3).

The TRY-CPAP algorithm does not advocate using CPAP for neonates <1kg (representing poor prognosis, group 4) nor in neonates with poor tone (representing HIE, group 5). 34 of these 101 neonates received CPAP (Table 3) when TRY-CPAP suggests that they shouldn't. Specifically, in Group 5 (<1kg) there was a 93% mortality with only 3 neonates surviving. These three surviving neonates had weights between 820g and 940g. These three neonates all received CPAP.

Table 1: Baseline data

	Muhima (n=112, 62.6%)	CHUK (n=66, 36.9%)	Both (n=178)
Male Gender	55/111 (49.5%)	37/66 (56.1%)	92/177 (52%)
Mean gestation	35.4 weeks (SD: 5.4)	31 weeks (SD: 3.8)	33.4 weeks (SD: 5.3)
Number of patients recruited by TRY-CPAP group	0/112 (0%)	13/66 (19.7%)	13/178 (7.3%)
- Group 1	18/112 (14.8%)	15/66 (22.7%)	33/178 (18.5%)
- Group 2	17/112 (13.9%)	11/66 (16.7%)	28/178 (15.7%)
- Group 3	55/112 (49.1%)	5/66 (7.6%)	60/178 (33.7%)
- Group 4	22/112 (19.6%)	22/66 (33.3%)	44/178 (24.75)
Gestational groups			
- Term (>37 weeks)	42/79 (53.1%)	6/62 (9.7%)	48/141 (34%)
- 32-37 weeks	14/79 (17.7%)	20/62 (32.3%)	34/141 (24.1%)
- 28-32 weeks	14/79 (17.7%)	24/62 (38.7%)	38/141 (27%)
- <28 weeks	9/79 (11.4%)	12/62 (19.4%)	21/141 (14.9%)
Mean birth weight (Kg)	2.4 (SD: 1.01)	1.4 (SD: 0.82)	2.0kg (SD:1.1)
Antenatal visits	45/54 (83.3%)	59/62 (95.2%)	104/116 (89.6)
Mode of delivery:			
- Vaginal	73/97 (75.2%)	35/66 (53%)	108/163 (66.25%)
- Instrumental	1 (1%)	0 (0%)	1/163 (0.06%)
- Caesarian	16 (16.5%)	16 (24.2%)	32/163 (19.6%)
Respiratory distress at birth			
- None	46/86 (53.5%)	24/66 (36.4%)	70/152 (46%)
- Mild	25/86 (29.1%)	22/66 (33.3%)	47/152 (30.9%)
- Severe	15/86 (17.4%)	20/66 (30.3%)	35/152 (23%)

**figures represent where data available in chart-review, denominators reflect where data available*

Table 2: CPAP and oxygen use by gestational group

	Muhima (n=112, 62.6%)	CHUK (n=66, 36.9%)	Both (n=178)
Oxygen therapy during admission	85/110 (77.3%)	42/62 (67.7%)	127/178 (73.8%)
Received CPAP during admission	18/77 (23.4%)	50/59 (84.7%)	68/136 (43.3%)
Received CPAP by gestational age:			
- term (>37weeks)	4/42 (9.5%) **	2/4 (50%) ***	6/46 (13%) ****
- 32 to <37 weeks	5/14 (35.7%)	14/20 (70%)	19/34 (55.9%)
- 28 to <32 weeks	4/14 (28.6%)	23/24 (95.8%)	27/38 (71.1%)
- <28 weeks	5/7 (71.4%)	11/11 (100%)	16/18 (88.9%)
Days on CPAP (where employed and information available)	2.56 days (n=18)	5.02 days (n=53)	4.39 days (n=71)
Mean length of stay	29.9 days	25.0 days	28.1 days
Median length of stay	5 days	11 days	6.5 days
Mortality rate	33/112 (29.5%)	42/66 (63.4%)	75/178 (42.0%)

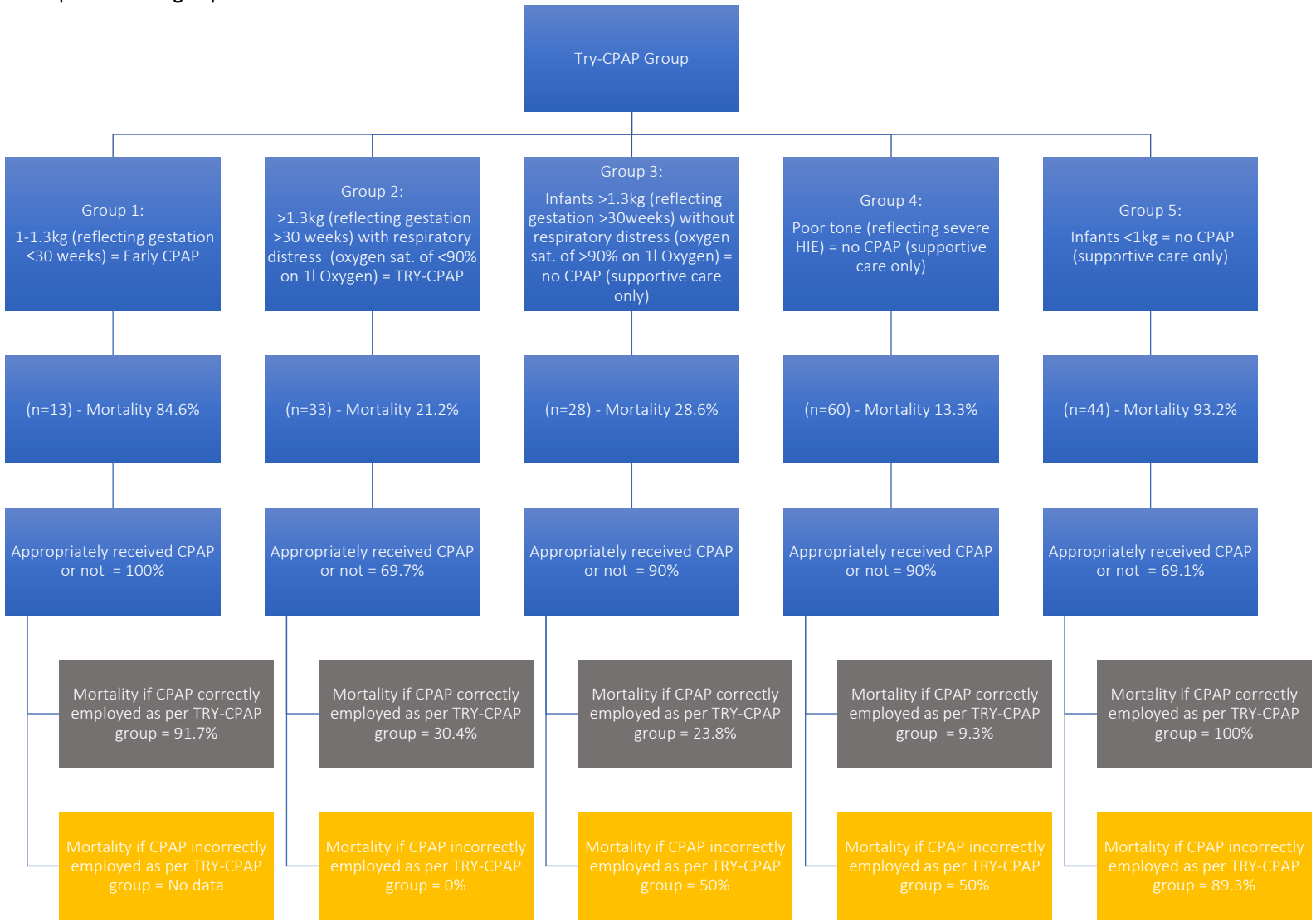
**figures represent where data available in chart-review, denominators reflect where data available*
***Chi-squared (df=8) = 44.5, p<0.001, ***Chi-squared (df=8) = 25.8, p=0.001, ****Chi-squared (df=8) = 72.3, p<0.001*

Table 3: TRY-CPAP groups

	Group 1 (n=13) Early CPAP	Group 2 (n=33) TRY CPAP	Group 3 (n=28) no CPAP	Group 4 (n=60) no CPAP	Group 5 (n=44) no CPAP	Total (n=178)
Received CPAP	12/12 (100%)	23/33 (69.7%)	6/27 (22.2%)	6/60 (10%)	28/41 68.2%)	75/173 (43.4%)
Mean number of days on CPAP (if CPAP administered)	5.3	2.9	2.7	3.7	6	4.4
Mortality	11/13 (84.6%)	7/33 (21.2%)	8/28 (28.6%)	8/60 (13.3%)	41/44 (93.2%)	75/178 (42.1%)
Appropriately received CPAP or not (as per TRY-CPAP)	12/12 (100%)	23/33 (69.7%)	21/27 (77.8%)	54/60 (90%)	13/41 (31.7%)	123/173 (71.1%)
Mortality in neonates where CPAP correctly employed according to TRY-CPAP group	11/12 (91.7%)	7/23 (30.4%)	5/21 (23.8%)	5/54 (9.3%)	13/13 (100%)	NA
Mortality in neonates where CPAP incorrectly employed according to TRY-CPAP group	No data	0/10 (0%)	3/6 (50.0%)	3/6 (50%)	25/28 (89.3%)	NA

*figures represent where data available in chart-review, denominators reflect where data available

Figure 2: Outcomes as per TRY-CPAP group



DISCUSSION

This study retrospectively assessed the use of CPAP in neonates admitted to the neonatal units of a referral hospital and a district hospital compared to the TRY-CPAP algorithm which has not been implemented in Rwanda. CPAP is a cost-effective, easy to use, safe and relatively non-invasive intervention. These are big advantages in countries such as Rwanda, where mechanical ventilation is scarce. However, correct identification of who would benefit the most from CPAP is still challenging.

Without the formal introduction and implementation of the TRY-CPAP algorithm, neonates were spontaneously allocated to the correct TRY-CPAP groups in 71% of cases. This accuracy is better than what was found in a similar study in three Rwandan hospitals [11]. Groups 3, 4 & 5 of the TRY-CPAP algorithm should not receive CPAP and in our study and this was done in 68% of cases in concordant manner to the algorithm (Table 3).

Of the six neonates with HIE who received CPAP, three survived and were discharged. The TRY-CPAP algorithm suggests supportive care only in these neonates (i.e. no CPAP). To date there has been no robust controlled trial looking at the use of CPAP in in neonates with respiratory distress and HIE in the resource-limited setting; this warrants attention.

We found three neonates with a birth weight <1kg on CPAP who survived and were discharged. Survival in infants <1kg is improving in the resource-limited setting. If a TRY-CPAP equivalent was to be implemented in Rwanda, more work would need to be done to identify a "treatment threshold" for initiating CPAP and to minimize the number of neonates who have a reasonable chance of survival with CPAP being deprived this resource.

In summary, the TRY-CPAP algorithm shows promise as an effective tool to ration the use of CPAP in this resource-limited setting. However, further work is required to identify appropriate thresholds for each treatment group and how best to implement in this setting.

Limitations of the study: Opportunistic/convenience sampling was used to recruit subjects and the overall mortality rate and distribution of cases to groups does not represent the true proportions at these two sites and rather the convenience sampling of neonates into the five TRY-CPAP groups. For example, there was a large number of neonates diagnosed with HIE and neonates <1.3kg. Availability of required information in the case-files at both sites limited data collection and therefore analysis.

REFERENCES

[1] S. G. Hundalani, R. Richards-Kortum, M. Oden, K. Kawaza, A. Gest, and E. Molyneux, "Development and validation of a simple algorithm for initiation of CPAP in neonates with respiratory distress in Malawi," Arch. Dis. Child. - Fetal Neonatal Ed., vol. 100, no. 4, pp. F332–F336, 2015.

[2] R. Rezzonico et al., "Impact of the systematic introduction of low-cost bubble nasal CPAP in a NICU of a developing country: a prospective pre- and post-intervention study.," BMC Pediatr., vol. 15, p. 26, 2015.

[3] K. Kawaza et al., "Efficacy of a low-cost bubble CPAP system in treatment of respiratory distress in a neonatal ward in Malawi," Malawi Med. J., vol. 28, no. 3, pp. 131–138, 2016.

[4] T. Duke, "CPAP: a guide for clinicians in developing countries," Paediatr. Int. Child Health, vol. 34, no. 1, pp. 3–11, Feb. 2014.

[5] E. a. Jensen, S. B. DeMauro, and H. Kirpalani, "Has enough evidence accumulated to consider CPAP a first-line standard of care in developing countries?," Arch. Dis. Child. - Fetal Neonatal Ed., vol. 99, no. 6, pp. F443–F444, 2014.

[6] Z. S. Lassi, P. F. Middleton, C. Crowther, and Z. A. Bhutta, "Interventions to Improve Neonatal Health and Later Survival: An Overview of Systematic Reviews," EBioMedicine, vol. 2, no. 8, pp. 985–1000, 2015.

[7] P. Mazmanyan, K. Mellor, C. J. Dore, and N. Modi, "A randomised controlled trial of flow driver and bubble continuous positive airway pressure in preterm infants in a resource-limited setting," Arch. Dis. Child. Fetal Neonatal Ed., vol. 101, no. 1, pp. F16–F20, 2016.

[8] R. M. McAdams et al., "Implementation of Bubble CPAP in a Rural Ugandan Neonatal ICU," Respir. Care, vol. 60, no. 3, pp. 437–445, Mar. 2015.

[9] N. Gupta, S. S. Saini, S. Murki, P. Kumar, and A. Deorari, "Continuous positive airway pressure in preterm neonates: An update of current evidence and implications for developing countries," Indian Pediatrics, vol. 52, no. 4. pp. 319–328, 2015.

[10] Rwanda_Ministry_of_Health, "Rwanda National Neonatal Protocols.," 2014.

[11] E. Nahimana et al., "Bubble CPAP to support preterm infants in rural Rwanda: a retrospective cohort study.," BMC Pediatr., vol. 15, no. 1, p. 135, 2015.

[12] E. Von Elm, D. G. Altman, M. Egger, S. J. Pocock, P. C. Gøtzsche, and J. P. Vandenbroucke, "The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: Guidelines for reporting observational studies," PLoS Med., vol. 4, no. 10, pp. 1623–1627, 2007.