

IS CPAP A FEASIBLE TREATMENT MODALITY IN A RURAL DISTRICT HOSPITAL FOR NEONATES WITH RESPIRATORY DISTRESS SYNDROME?

Hans Jurgen Hendriks

Thesis presented in partial fulfilment of the requirements for the degree of Masters in Family Medicine at the University of Stellenbosch.



Supervisor: Professor H. Conradie, Division of Family Medicine and Primary Care, Faculty of Health Sciences, University of Stellenbosch

Co-supervisor: Professor G. Kirsten, Division of Neonatology, Department of Pediatrics, Tygerberg Hospital

June 2010

Table of Contents

1. Declaration.....	3
2. Abstract.....	4
3. Figures and Tables.....	6
4. List of abbreviations.....	7
5. Introduction.....	8
6. Literature review	11
7. Aims and Objectives.....	15
8. Study design and methods.....	16
9. Ethical Considerations.....	19
10. Results.....	19
11. Discussion.....	34
12. Recommendations.....	40
13. Conclusion.....	42
14. References.....	43
15. Appendices.....	44

1. Declaration

I, the undersigned, hereby declare that the work contained in this assignment is my original work and that I have not previously submitted it, in its entirety or in part, at any university for a degree.

Signature

Date.....

2. Abstract

Title: Is CPAP a feasible treatment modality for neonates with respiratory distress syndrome in a rural district hospital?

Hendriks H*, Conradie H**, Kirsten GF***, Holgate S***, Post A***. *Ceres District Hospital, **Division of Family Medicine and Primary Care, Faculty of Health Sciences, University of Stellenbosch, ***Division of Neonatology, Department of Paediatrics, Tygerberg Children's Hospital.

Introduction: Limited facilities exist at rural hospitals for the management of newborn infants with respiratory distress syndrome (RDS). Furthermore, the secondary and tertiary hospitals are under severe strain to accept all the referrals from rural hospitals. Many of these infants require intubation and ventilation with a resuscitation bag which must be sustained for hours until the transport team arrives. Not only is lung damage inflicted by the prolonged ventilation, but transferring the infant by helicopter and ambulance is expensive.

CPAP (continuous positive airway pressure), a non-invasive form of ventilatory support, has been used successfully at regional (Level 2) and tertiary (Level 3) neonatal units, to manage infants with RDS. It is cost-effective for infants with mild to moderate grades of RDS to be managed at the rural hospital instead of being transferred to the regional secondary or tertiary hospital. CPAP was introduced to Ceres Hospital, a rural Level 1 hospital, in February 2008 for the management of infants with RDS.

Aim: To determine the impact of CPAP on the management of infants with RDS in a rural level 1 hospital and whether it can reduce the number of referrals to regional hospitals.

Study setting: Nursery at Ceres District Hospital, Cape Winelands District, Western Cape.

Study design: Prospective cohort analytical study with an historic control group (HCG).

Patients and Methods: The study group (SG) comprised all neonates with respiratory distress born between 27/02/2008 and 26/02/2010. The infants were initially resuscitated with a Neopuff® machine in labour-ward and CPAP was commenced for those with RDS. The survival and referral rates of the SG were compared to an historic control group (HCG) of infants born between 1/2/2006 to 31/01/2008 at Ceres Hospital.

Results: During the 2 years of the study, 51 neonates received CPAP (34 <1800g, 17 >1800g). Twenty (83%) of the SG infants between 1000g and 1800g and 23 (68%) of the infants between 500g and 1800g survived. Those <1800g that failed CPAP, had either a severe grade of RDS which required intubation and ventilation or were <1000g. Seventeen (33%) of the infants that received CPAP, were in the >1800g group. Thirteen (76%) of these infants were successfully treated with CPAP only. The four infants that failed CPAP suffered from congenital abnormalities and would not have benefited from CPAP. There was no statistically significant difference in the survival between the SG and HCG (80%) ($p=0.5490$)

but the number of referrals decreased significantly from 21% in the HCG to 7% in the SG ($p=0.0003$). No complications related to CPAP treatment, such as pneumothorax, were noted. The nursing and medical staff quickly became proficient and confident in applying CPAP and were committed to the project.

Conclusion: CPAP can be safely and successfully practised in infants with mild to moderate RDS in a rural Level 1 hospital. The survival rate stayed the same as the HCG, even though a higher risk infants were treated in the SG. The transfers were significantly reduced from 21% to 7%. This resulted in significant cost savings for the hospital.

3. Figures and Tables

Figures

Figure 1: Ceres District Hospital.....	p.8
Figure 2: Referral routes.....	p.9
Figure 3: Neonatal CPAP Unit.....	p.10
Figure 4: Schematic diagram of a Bubble CPAP Circuit.....	p.13

Tables

Table 1: Maternal data of infants <1800g in CPAP group.....	p.20
Table 2: Clinical data of infants <1800g in CPAP group.....	p.21
Table 3: CPAP data of infants <1800g in CPAP group.....	p.22
Table 4: Two Years of CPAP: 34 neonates <1800g.....	p.23
Table 5: Outcome of infants <1800g in Pre-CPAP group.....	p.25
Table 6: Comparative table of Pre-CPAP and CPAP years.....	p.26
Table 7: Maternal and clinical data of infants >1800g that received CPAP.....	p.27
Table 8: CPAP data of infants >1800g.....	p.28
Table 9: Results of self-scoring.....	p.31
Table 10: CPAP Protocols: Saturation Monitoring.....	p.40

4. List of abbreviations

ATN – Acute Tubular Necroses
ChildPIP – Child Problem Identification Program
CPAP – Continuous Positive Airway Pressure
CSMO – Community Service Medical Officer
ELBW – Extreme Low Birth Weight
ENND – Early Neonatal Death
FiO₂ – Fraction of Inspiratory Oxygen
GP – General Practitioner
HCG – Historic Control Group
HIE – Hypoxic Ischemic Encephalopathy
HMD – Hyaline Membrane Disease
ICU – Intensive Care Unit
IVH – Intraventricular Haemorrhage
KMC – Kangaroo Mother Care
LB – Live Birth
LBW – Low Birth Weight
LND – Late Neonatal Death
MO – Medical Officer
nCPAP – nasal Continuous Positive Airway pressure
NICU – Neonatal Intensive Care Unit
O₂ - Oxygen
PDA – Patent Ductus Arterioses
PEEP – Positive End Expiratory Pressure
PI – Principal Investigator
PMO – Principle Medical Officer
PN – Professional Nurse
PPIP – Perinatal Problem Identification Program
RDS – Respiratory Distress Syndrome
SaO₂ – Saturation of arterial blood by Oxygen
SG – Study Group
VLBW - Very Low Birth Weight
V-nCPAP – Ventilator nasal Continuous Positive Airway Pressure
VSD – Ventricular Septal Defect

5. Introduction to Study:

Context of the problem:

Rural hospitals are severely limited when treating neonates with respiratory problems after birth. If initial resuscitation and O₂ administered by nasal prongs/head box (*kopkassie*) does not help, medical personnel are usually forced to transfer the patient to a secondary/tertiary hospital, usually after intubation and ventilation and then transported by helicopter/ambulance assisted by a paramedic. Intubation and ventilation are associated with morbidity and mortality risks and the transfer costs are high. When this is added to a severely limited medical transport service and overloaded referral hospitals, one realizes that treatment at the primary setting would be ideal. CPAP gives one the option to do much more at the primary level. It is easy and cost effective to install and user friendly: Nursing staff and doctors can be trained in its use in one day. Definitive treatment or support can then theoretically be done at primary level, lowering transfers (and thus costs) and lowering morbidity and mortality.

Setting of the study:

The study was done at Ceres District Hospital. On 27/02/2008, Prof Gert Kirsten from Division of Neonatology, Tygerberg Hospital, together with a team of doctors and PNs (Professional Nurses), presented a workshop on the theory behind CPAP and the practical application of CPAP. On the same day the first neonate was started on CPAP after developing respiratory distress after birth. This 1480g baby girl was weaned off CPAP after 18 hours and later discharged at 1800g after an uneventful KMC (Kangaroo Mother Care) period.



Figure 1: Ceres District Hospital

Ceres Hospital is a district hospital situated in the Witzenberg sub-district of the Cape Winelands District of the Western Cape Province. It serves a predominantly rural population of 102 000 people in an area of which only 4% is built up/semi-urban. The main income in the area is generated by agriculture.

Referral hospitals are Worcester Hospital (secondary), 50 km from Ceres, and Tygerberg Hospital (tertiary) 150km from Ceres.

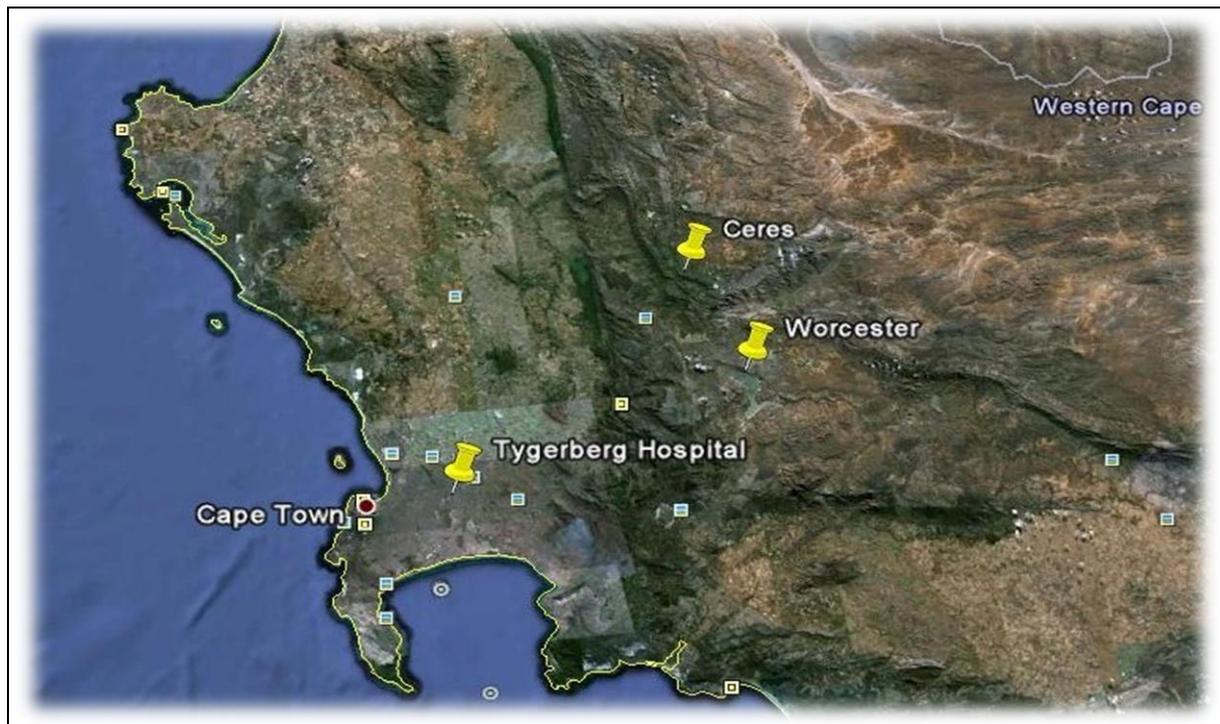


Figure 2: Referral routes

The hospital functions with 6 government doctors (2 principle medical officers (PMO's), 1 medical officer (MO) and 3 community service medical officers (CSMO's)). They are assisted by 4 general practitioners (that have private practices in Ceres), to cover all overtime in the hospital. A paediatrician visits the hospital once a month for morbidity and mortality meetings.

The labour ward together with the neonatal and KMC units is combined in a ward separate from the rest of the hospital. The nursing personnel on the day shift consist of 2 professional nurses (PN), 1 staff nurse and 2 assistant nurses (5 in total). The night shift has 1 PN and 2 nurses (3 in total). The personnel are responsible for all deliveries, neonatal care and the KMC unit.

The hospital delivers on average (over a 9-year period) 1620 births per year or 135 per month⁹. Twenty two percent of the deliveries are below 2500g, thus Low Birth Weight (LBW)⁹.



Figure 3: Neonatal CPAP unit at Ceres Hospital

Motivation for undertaking the study:

The researcher hoped that by doing this study, evidence would be obtained that validates nCPAP as a feasible and effective treatment modality in the rural setting. The data thus obtained may then warrant the introduction of CPAP at all rural hospitals in South Africa and thereby introduce a treatment modality that can have a positive effect on the outcome of neonates in these rural settings as well as lowering transfers to referral hospitals and transfer costs.

A quote from the study by Koyamaibole et al explains the rural dilemma and advantage of CPAP well: *"Safe mechanical ventilation requires a high level of expertise, and the constant availability of trained medical staff. This is rarely a reality in provincial or district hospitals in developing countries, but these hospitals admit a large proportion of seriously ill neonates. Therefore it is highly advantageous if a simpler and cheaper intervention can significantly reduce the need for mechanical ventilation with at least the same survival rate."*⁶

CPAP may be this solution.

6. Literature Review

Introduction:

This literature review will attempt to explore the following question: *“Is nCPAP a feasible treatment modality in a rural district hospital for neonates with respiratory distress syndrome?”*. It will be thematically organized as follows:

- i. Technical description of CPAP and evidence to support its use in hospitals.
- ii. Discussion of safety and efficacy of CPAP in ELBW infants.
- iii. Discussion on a comparison between Bubble nCPAP and ventilator-derived nCPAP.
- iv. Discussion of an article that supports its use in the rural setting.
- v. Summary of literature search.

(i) Technical Discussion on nCPAP

What is nCPAP?:

Nasal continuous positive airway pressure (nCPAP) was first used to support the breathing of infants in 1971. By applying nasal prongs to neonates and blowing air (medical air/O₂ mixture, according to need) at a specific pressure through the prongs, one can generate a positive airway pressure in the neonate's lungs. The physiological effect of this is improving oxygenation, maintaining lung volume, lowering upper airway resistance and reducing obstructive apnoea.^{1,2} As a result it can be effectively used in many neonatal respiratory conditions, including the prevention of extubation failure, prevention of apnoea of prematurity and as an alternative to intubation and mechanical ventilation in neonates with respiratory distress syndrome (RDS).^{1,2}

nCPAP devices: Which is best?

There are many devices available, including single and double (binasal) prongs in the short (nasal) and long (nasopharyngeal) forms. A meta-analysis of randomized controlled trials done, provided evidence that short binasal prongs are more effective at preventing re-intubation after extubation than other devices¹. One randomized controlled trial reported better results where short binasal prongs were used when compared with a single nasopharyngeal prong.¹

What is the optimal flow setting?

The flow setting is influenced by the leak created by the mouth and nose. By closing the mouth (with pacifier or by direct closure) and using the nasal prong with best fit, one can reduce the leak and thereby reduce the necessary flow. The optimal flow as suggested by the literature available, is 6-8 l/min.^{1,3}

What is the optimal pressure?

Though the optimal nCPAP pressure is not known, it is traditionally believed that a pressure of 5cm H₂O is optimal.¹ Currently there is no evidence to suggest otherwise. Some ICUs have used higher pressures – up to 10cm H₂O – with good results.¹

Indications for nCPAP initiation, failure and weaning:

There are no clear criteria for initiation, failure or weaning of nCPAP. Commonly used criteria for introduction of nCPAP in the neonate is grunting, severe chest in-drawing, severe respiratory distress and saturation < 90% despite O₂ administration via headbox or nasal prongs³. Failure criteria in the infant treated for RDS is typically persistent, severe apnoeic attacks, PaCO₂ of ≥ 8.3 kPa, FiO₂ ≥ 0.6 (60%) to maintain acceptable O₂ saturation¹. Weaning can start once the infant has been stable on a FiO₂ of 21% on a pressure of 5mm H₂O¹. Different methods of weaning have been used, with no evidence to support specific methods.

nCPAP vs. Intubation and mechanical ventilation:

The reviewed literature agrees that nCPAP is an effective and safe alternative to endotracheal intubation and mechanical ventilation in the neonate¹⁻⁶. There is still a place for intubation and mechanical ventilation in the treatment of neonates with respiratory distress. The literature suggests that nCPAP be used first for neonates and if it fails, to intubate and ventilate³.

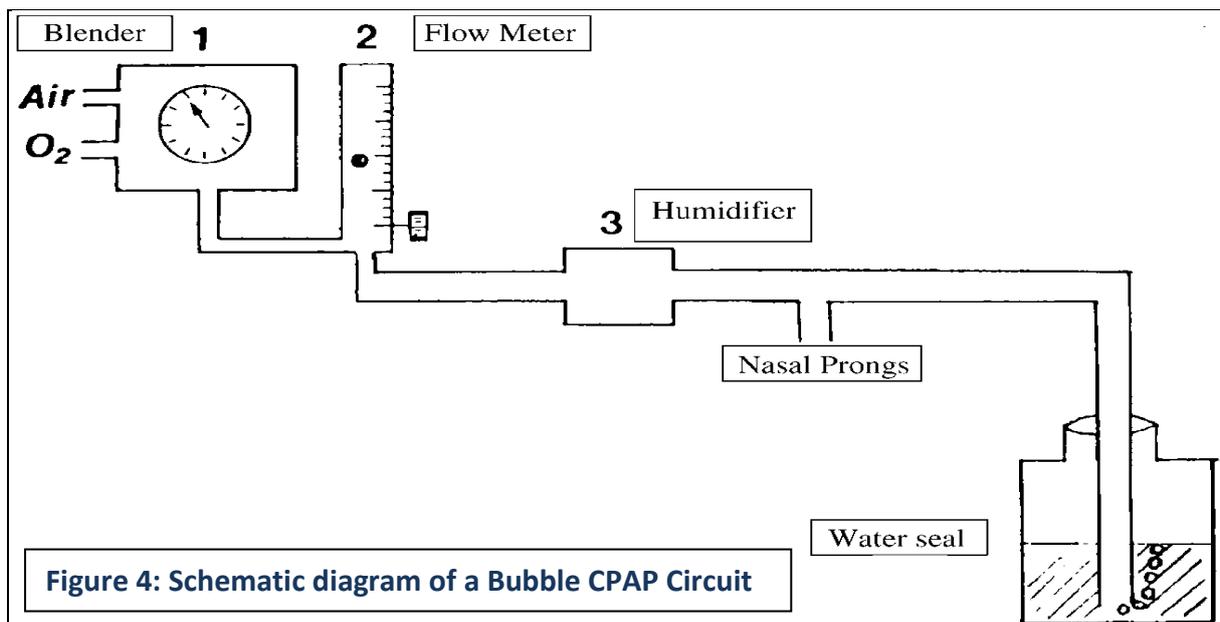
(ii) Safety and efficacy of CPAP in ELBW infants

The study by Narendran V. et al on the efficacy of bubble nCPAP compared two groups of neonates: one that received nCPAP and the other a historic control group that dated from the time before nCPAP was introduced at the hospital⁴. The control group consisted of 92 VLBW neonates (401-1000g) that were retrospectively selected from 1 January 1998 to 31 December 1999 (the time before nCPAP was introduced at the hospital). The study group consisted of 79 VLBW neonates that were treated with routine, early bubble nCPAP in the delivery room during the time period of 1 July 2000 and 10 October 2001.

They found that the bubble nCPAP reduced delivery room intubations, days of mechanical ventilation and postnatal steroid use. The use of CPAP was also associated with better weight gain during the postnatal period⁴.

(iii) **Discussion on comparison of Bubble nCPAP and ventilator-derived nCPAP**

Bubble CPAP is a low cost nasal delivery CPAP system where the expiratory arm of the system ends submerged under the desired centimetres of water supplies the desired cmH₂O of PEEP. Another system used to supply nCPAP, is the ventilator-derived nCPAP (V-nCPAP). In this system the ventilator controls the pressure delivered to the expiratory orifice.



In a randomised crossover study comparing 18 infants <1500g, Courtney et al found that work of breathing and ventilation were similar between bubble nCPAP and V-nCPAP⁵.

Tagare et al did a pilot randomised controlled trial where 30 preterm neonates needing nCPAP, were randomly allocated to bubble nCPAP or V-nCPAP. The two legs of the study compared favourably with the success rate (measured as survival of babies) of V-nCPAP = 80% (12/15) vs. bubble nCPAP = 87% (13/15)⁶.

(iv) **nCPAP in the rural setting**

As the subject of this study suggests, the aim is to evaluate nCPAP in a rural setting. Only one article could be found that applied CPAP in the rural setting. Koyamaibole et al did a study on CPAP in a developing country (Fiji) in 2003³. There are some differences and similarities between the Witzenberg population and the population in the study by Koyamaibole. Both countries are developing countries with a predominantly rural

population (41% in the Witzenberg sub district and 54% in the Fiji study ⁸). The infant mortality rate in the Witzenberg sub district is 42/1000 live births ⁹, much higher than the 17/ 1000 live births in Fiji ³. Health care systems are very similar with effective referral routes and transport. One big difference is that the study was done in a referral hospital (Colonial War Memorial Hospital, Fiji) with a neonatal intensive care unit (NICU) and fulltime paediatricians, compared to Ceres Hospital that is a level one hospital with a neonatal unit, but no NICU and no paediatricians on site. It is still comparable to Ceres Hospital where medical staff is always on call, mechanical ventilation available if nCPAP fails and good referral systems so that neonates that do not respond well to nCPAP and have to be intubated, can be referred to secondary or tertiary hospitals.

The results of the Koyamaibole et al. study were as follows:

- nCPAP was found to be a feasible and safe treatment modality in their setting that also (like Ceres Hospital) experienced personnel shortages with resulting nurse-patient ratios that were far less than would ideally be required.
- Nurses could safely apply the nCPAP after only 1-2 months of on-the-job training.
- The introduction of nCPAP was associated with a 50% reduction in the need for mechanical ventilation.
- There was no influence on the mortality rates between the pre- and post-nCPAP periods.

(v) Summary of literature search

- There is good evidence to support the use of nCPAP in the treatment of neonates with respiratory distress.
- The best nCPAP device is the short binasal prongs.
- Optimal flow settings are 6-8 l/min and pressure support of 5-10 cm/H₂O. (None of these 2 values are proven, but clinical trials suggest that it needs to be individualized for each patient. The flow and pressure values used should fall within these ranges.)
- There are no clear indications for initiation, failure or weaning of nCPAP.
- Evidence supports the use of nCPAP as an effective and safe alternative to endotracheal intubation and mechanical ventilation in the neonate.
- Bubble CPAP is a safe and effective treatment modality in VLBW neonates.
- Bubble CPAP compares favourably to V-CPAP, with similar outcomes.
- The study by Koyamaibole et al suggests that CPAP can be used effectively in resource limited countries, with good outcomes. It is easy to use, less invasive than intubation and lowers the need for mechanical ventilation. Koyamaibole et al reported that CPAP substantially reduced the need for mechanical ventilation in neonates, but had no influence on the mortality rate.

7. Aims and Objectives

Aims

1. To evaluate the effects of CPAP on survival and referral of neonates at a rural hospital.
2. To determine how nursing staff, doctors and mothers experience nCPAP.

Objectives

1. To do a detailed analysis of all neonates that received nCPAP at Ceres Hospital over a 2 year period and then to express the outcomes in terms of survival and referral rates.
2. To calculate and compare the referral and survival rates for < 1800g neonates for the time period before CPAP, February 2006 to February 2008 (historic control), with the first two years of CPAP capability, February 2008 to February 2010 (study group).
3. To evaluate the referral and survival rates for > 1800g neonates.
4. To determine the feelings and opinions of the mothers of neonates receiving CPAP and to evaluate their experience of the process.
5. To determine the subjective skills level and opinion of the health workers responsible for CPAP. To evaluate the experience of all personnel taking part in the CPAP program.
6. To describe the process of introduction of a CPAP program at a rural hospital.

8. Study design and methods

Study design:

The study has both a quantitative and a qualitative design. The quantitative study design is a “Before-after Design” as the researcher used a “before CPAP” group (historic control) to compare with the “CPAP group”(SG). The researcher wanted to evaluate the result of the intervention by comparing the CPAP group to a group that has not benefitted from the intervention.

The qualitative part used a semi-structured interview with mothers and health workers. The interview with the mothers determined their feelings and opinions of CPAP and the interview with health workers evaluated their experience of CPAP.

The study population and sampling procedures:

The study population was all the babies that were born in the Witzenberg sub-district during the period 01/02/2006 to 27/02/2010, including all the babies that were born before arrival at the obstetric unit. The Witzenberg sub-district is an area with a population of 102 000 people. All obstetric cases are referred to Ceres District Hospital, the only obstetric facility in the sub-district ⁸. All the neonates that received nCPAP (according to medical indications) were included in the study.

Method of data collection:

Three sources of information were used:

- The first was the PPIP (Perinatal Problem Identification Program) version 2.2 data that are collected from the labour ward maternity register. The information used from this source was the total number of live births in the different weight categories as well as early and late neonatal deaths for the years included in the study. (See appendix A)
- The second source of information was the register kept on all live babies born <1800g in the hospital. (These babies were all admitted for KMC.) This has been kept since 2002 and helped the researcher to calculate how many babies in the <1800g weight category were admitted, survived or died or were transferred to other hospitals and to which hospitals. The “<1800g register” helped in the analysis of data collected before and during the implementation of CPAP to calculate how Ceres Hospital’s transferrals and survivals were influenced by the intervention. All data collected were entered into a Excel spreadsheet. (See appendix B). The researcher compared this data to the PIPP data to validate accuracy.
- The third source of information was the information collected on all the neonates and their mothers that received CPAP (See appendix C). This information was entered into a Microsoft Office Excel spreadsheet. (See appendix D)

- The fourth source of information was the semi-structured interviews conducted with mothers of neonates that received CPAP and health personnel involved in the CPAP program. (See appendix E)

Statistical analysis:

The researcher was assisted in the statistical analysis by the “Centre for Statistical Consultation” at the University of Stellenbosch.

MS Excel was used to capture the data and STATISTICA version 8 (StatSoft Inc. (2008) STATISTICA (data analysis software system), www.statsoft.com.) was used to analyze the data. Summary statistics were used to describe the variables. Distributions of variables were presented with histograms and or frequency tables. Medians or means was used as the measures of central location for ordinal and continuous responses and standard deviations and quartiles as indicators of spread. The relationships between continuous response variables and nominal input variables were analyzed using analysis of variance (ANOVA). Correlations among continuous and/or ordinal variables were expressed using Spearman’s or Pearson’s correlation coefficients. Relations between nominal variables were investigated with contingency tables and likelihood ratio chi-square tests. A p-value of $p < 0.05$ will represent statistical significance in hypothesis testing and 95% confidence intervals will be used to describe the estimation of unknown parameters.

9. Ethical Considerations

It was the primary concern of the principal investigator (PI) to protect the safety, well-being and dignity of all participants in this study. Culture, language, beliefs, perceptions and customs were taken into consideration at all times by, for example, using translators.

The study is especially relevant for the South African context where severe strain on the health system due to financial constraints and patient numbers, puts pressure on the health department to search for more cost effective treatment modalities while not lowering standards.

No consent was asked before neonates were initiated on nCPAP. The literature searches done beforehand indicated that nCPAP is a safe, effective treatment modality from which the neonate would benefit. (See literature review.) The risk/benefit analysis is strongly in favour of treatment with nCPAP. Since the health of the patient is the main concern, all neonates that qualify for nCPAP (according to specific criteria), received it.

The PI wished to evaluate the treatment modality as it was used in the rural setting. Success of the treatment modality was continuously evaluated for adverse events or problems that may have led to the detriment of the patients.

Data used and storage of data, was done in such a way that privacy and confidentiality of all participants were protected.

There was no conflict of interest, since the PI had no financial or other gain, as a result of producing a positive/negative result in this study.

All results will be published at completion of the study.

10. Results

Results will be discussed under the following headings:

- i. Neonates <1800g
- ii. Statistical analysis
- iii. Neonates >1800g
- iv. Semi-structured interviews
- v. Description of CPAP process at Ceres Hospital

In the 2 year period that CPAP was available at Ceres Hospital, 51 neonates received CPAP. They were separated into 2 groups for analysis. The reason for this is that at Ceres Hospital, personnel keep a “<1800g register”. All neonates <1800g are kept for KMC, and information of date of birth, birth weight/discharge-weight, CPAP/or not and death/referral/discharge date are entered into this register. As a result of the availability of this register for the 2 years before CPAP, the researcher could create a historic control group (HCG) to compare the <1800g neonatal survival and referral rates before and after CPAP was introduced.

i. Neonates <1800g

Thirty four neonates <1800g received CPAP during the 2 year CPAP period. The study group (SG) were compared to the HCG to evaluate the effect of CPAP on survival and referral rates.

Study Group

In the SG 148 neonates <1800 were born in the 2 year period (34 <1000g, 57 1000g-1500g, 57 1500g-1800g). Ten neonates received CPAP in the <1000g group (29%), 21 in the 1000g-1500g group (37%) and 3 in the 1500g-1800g group (0.5%). In total 34 of the 148 neonates received CPAP (23%).

Information on the mothers whose neonates received CPAP (see table 1):

Table 1: Maternal data of the Infants <1800g in CPAP Group

Birth weight (g)	<1000	1000 - 1499	1500 - 1800	All
Total number born	34	57	57	148
Number who received nCPAP (%)	10(29)	21(37)	3(5)	34(23)
Mean age of mother (years)	25	26	28	26
Antenatal steroids (%)	7(70)	9(43)	0	16(47)
Time antenatal steroids administered before delivery (Average hours)	40	93	0	42
Booked (%)	9(90)	18(86)	3(100)	30(88)
Pre-eclampsia / HELLP(%)	0	3(14)	0	3(9)
Caesarean section (%)	1(10)	6(29)	2(67)	9(26)

- Mean age of mothers: 26 years
- Antenatal steroids (Betamethasone 12gm IMI x 2, 24hours apart) given in 16/34 cases (47%)
- Average time steroids were given before birth: 42 hours
- Antenatal bookings at clinic: 30/34 (88%)
- Pre-eclampsia/ HELLP syndrome: 3/34 (9%)
- Caesarean sections: 9/34 (26%)

Information on neonates that received CPAP (see table 2, 3, 4):

Table 2: Clinical data of infants <1800g in CPAP group

Birth weight (g)	<1000	1000 - 1499	1500 - 1800	All
Total number born	34	57	57	148
Number who received nCPAP(%)	10(29)	21(37)	3(5)	34(23)
Mean birth weight (g)	874	1247	1567	1166
Mean gestational age (weeks)	28	31	36	31
Male (%)	4(40)	16(76)	2(67)	22(65)
Born before arrival at hospital (%)	1(10)	6(29)	1(33)	8(24)

Table 3: CPAP data of infants <1800g in CPAP group

Birth weight (g)	<1000	1000 - 1499	1500 - 1800	All
Total number born	34	57	57	148
Number who received nCPAP (%)	10(29)	21(37)	3(5)	34(23)
Resuscitation with Neopuff (%)	5(50)	6(29)	2(67)	13(38)
Mean age at initiation of nCPAP in hours (max)	10.35 (96)	1.7 (4.5)	160(480)	83(480)
Mean duration of nCPAP in hours (max)	51 (162)	27 (102)	14 (20)	33(162)
Total hours nCPAP (h)				1116.5
Mean highest FiO₂ on nCPAP (%)	65	45	31	50
Failed nCPAP (%)	7(70)	4(19)	0	11(32)
Intubated (%)	0	3(14)	1(33)	4 (12)

Table 4: Two Years of CPAP: 34 neonates <1800g

Birth weight (g)	<1000	1000 - 1499	1500 - 1800	All
Total number born	34	57	57	148
Number who received nCPAP (%)	10(29)	21(37)	3(5)	34(23)
Number of successful nCPAP treatments (%)	3(30)	17 (81)	3(100)	23(68)
nCPAP success in 1000g-1800g neonates		17(81)	3(100)	20(83)
Diagnosis in cases where nCPAP “failed”	<ul style="list-style-type: none"> • 6xHMD • 1x HIE 	<ul style="list-style-type: none"> • 1x Gr4 HMD • 1x Gr 2 HMD, PDA • 1x Gr3 HMD, Gr4 IVH, PDA,ATN • 1x Gr2 HMD 		
Number of transfers (%) and diagnosis at referral hospitals of these transfers	1(10) <ul style="list-style-type: none"> • Gr3 HMD 	4(19) <ul style="list-style-type: none"> • Gr 4 HMD,PDA • Gr2 HMD, PDA • Gr3 HMD, Gr4 IVH,PDA,ATN • GR 3 HIE 	0	5(15)

- Mean birth weight: 1166g
- Mean gestational age: 31 weeks
- Male: 22/34 (65%)
- Born before arrival at hospital: 8/34 (24%)
- Resuscitation with Neopuff®: 13/34 (38%)
- Mean age at initiation of CPAP: 83 hours
 - <1000g neonates: 10.35 hours (max 96 hours)
 - 1000g-1500g neonates: 1.7 hours (max 4.5 hours)
 - 1500g-1800g neonates: 160 hours (max 480 hours)
- Mean duration of CPAP: 33 hours (max 162 hours)
 - <1000g neonates: 51 hours (max 162 hours)
 - 1000g-1500g neonates: 27 hours (max 102 hours)
 - 1500g-1800g neonates: 14 hours (max 20 hours)
- Total hours CPAP given in 2 year period <1800g neonates: 1116.5 hours
- Mean highest FiO₂: 50% O₂
- Neonates on CPAP that needed intubation: 4/34 (12%)
- Successful CPAP: 23/34 (68%)
 - <1000g neonates: 3/10 (30%)
 - 1000g-1500g neonates: 17/21 (81%)
 - 1500g-1800g neonates: 3/3 (100%)
- Diagnosis where CPAP “failed”:
 - <1000g neonates: 6 x HMD, 1 x HIE (7 total)
 - 1000g-1500g neonates: 1 x Grade (Gr) 4 HMD, 1 x Gr 2 HMD with PDA, 1 x Gr 3 HMD with Gr 4 IVH with PDA and ATN, 1 x Gr 2 HMD (4 total).
 - 1500g-1800g: no failed CPAP
- **Survival of neonates in SG: 105/132 (80%)**
 - <1000g neonates: 11/31 (35%)
 - 1000g-1500g neonates: 42/48 (88%)
 - 1500g-1800g neonates: 52/53 (98%)

(It is important to note that transfers and non-CPAP-preventable deaths were subtracted from the total number of neonates to calculate “CPAP influenced” survival.)
- Number of transfers: 5/34 (15% of CPAP neonates)
 - <1000g neonates: 1/10 (Gr 3 HMD)
 - 1000g-1500g neonates: 4/21 (Same 4 as named above under failed CPAP)
 - 1500g-1800g neonates: 0 transferrals

- During the 2 years of CPAP, 10 <1800g neonates were transferred (of which 5 received CPAP, but still needed transfer). Thus 10/148 neonates were transferred (6.75%)

Historic Control Group (see table 5)

Table 5: Outcome of infants <1800g in Pre-CPAP group.

Birth weight (g)	<1000	1000 – 1500	1500 - 1800	All
Number	29(ENNDs+LNDs+LBs)	63	79	171
Survived (%)*	7/23 (30)	36/41 (88)	65/67 (97)	108(82)
Survived 1000 – 1800g(%)		36/41 (88)	65/67 (97)	133(92)
Number of Transfers	4	20	12	36
% of total transferred	14	32	15	21

In the HCG 171 neonates <1800g were born during the 2 year period (29 <1000g, 63 1000g-1500g, 79 1500g-1800g).

Information on neonates from the HCG:

- **Survival of neonates <1800g: 82%**
 - <1000g neonates: 7/23 (30%)
 - 1000g-1500g neonates: 36/41 (88%)
 - 1500g-1800g neonates: 65/67 (97%)

(It is important to note that when survival was calculated, the neonates that were transferred from the weight group were subtracted from the total number in the group.)
- **Number of transfers: 36/171 (21%)**

- <1000g neonates: 4/29 (14%)
- 1000g-1500g neonates: 20/63 (32%)
- 1500g-1800g neonates: 12/79 (15%)

ii. Statistical analysis

Statistical analysis was carried out on the SG and HCG of the <1800g neonates.(See table 6)

Table 6: Comparative table of Pre-CPAP and CPAP years

Birth Weight	<1000g		1000-1499g		1500-1800g		Totals		P-value
	Pre-CPAP	CPAP	Pre-CPAP	CPAP	Pre-CPAP	CPAP	Pre-CPAP	CPAP	
Total number of Neonates	29	34	63	57	79	57	171	148	
Survival (%)	7/23 (30)	11/31 (35)	36/41 (88)	42/48 (88)	65/67 (97)	52/53 (98)	108/131 (82)	105/132 (80)	0.5490
Transfers(%)	4 (14)	2 (6)	20 (32)	4 (7)	12 (15)	4 (7)	36 (21)	10 (7)	0.0003

The results were as follows:

- Survival:
 - In the HCG 108/131 neonates survived (82.44%)
 - In the SG 105/132 neonates survived (79.54%)
 - **There is no statistically significant difference between the HCG and SG, with a p-value of p = 0.5490.**

- Transfers:
 - In the HCG 36/171 neonates were transferred (21.05%)
 - In the SG 10/148 neonates were transferred (6.75%)
 - **There is a statistically significant difference between the HCG and SG, with a p-value of $p = 0.0003$.**

iii. **Neonates >1800g** (see table 7,8)

Table 7: Maternal and clinical data of infants >1800g that received CPAP

Mean age of mother (years)	24
Booked (%)	17(100)
Pre-eclampsia / HELLP(%)	1(6)
Caesarean section (%)	4(24)
Mean birth weight (g)	2638
Mean gestational age (weeks)	37.7
Male (%)	13(76)
Born before arrival at hospital (%)	1(6)

Table 8: CPAP data of infants >1800g

Resuscitation with Neopuff (%)	10(59)
Mean age at initiation of nCPAP (Hours)(max)	3 (14)
Mean duration of nCPAP (hours) (max)	13 (28)
Total hours nCPAP (hours)	227
Mean highest FiO₂ on nCPAP (%)	43
Failed nCPAP (%) (All were intubated and referred)	4 (24)
Diagnosis at referral hospitals	<ul style="list-style-type: none"> • Coanal Atresia • Gr2 HIE, Congenital Pneumonia • VSD, PDA, Pulmonary atresia • Congenital diaphragmatic hernia

Seventeen neonates >1800g received CPAP in the 2 year period. (1/3 of total number of CPAP cases.)

The following information was gained from these cases:

- Mean age of mothers: 24 years
- Antenatal bookings: 17 (100%)
- Pre-eclampsia/HELLP syndrome: 1/17 (6%)
- Caesarean sections: 4/17 (24%)
- Mean birth weight: 2638g
- Mean gestational age: 37.7 weeks
- Male neonates: 13/17 (76%)
- Born before arrival at hospital: 1/17 (6%)

- Resuscitation with Neopuff®: 10/17 (59%)
- Mean age at initiation of CPAP: 3 hours (Max 14 hours)
- Mean duration of CPAP: 13 hours (Max 28 hours)
- Mean highest FiO₂: 43%
- Failed CPAP cases (all were intubated and transferred): 4/17 (24%)
- Diagnosis in 4 failed cases: Coanal atresia, Gr 2 HIE with congenital pneumonia, VSD with PDA with pulmonary atresia, Congenital diaphragmatic hernia.
- Total number of hours CPAP given: 227 hours
- **Successful CPAP cases** (where CPAP should have made a difference): **13/13 (100%)**
- **Total transfers: 4** (None were CPAP (as only treatment modality) preventable.

iv. Semi- structured Interviews with mothers and health personnel

The objective of this part of the study is to evaluate the feelings and opinions of the mothers, as well as the subjective skills level and opinions of health workers that are part of the nCPAP program. The participants were divided into 3 groups: Group A: mothers, B: nursing personnel and C: doctors. All were given a “Participant Information Leaflet and Consent Form” and then a short questionnaire with 5 questions to answer, if they gave consent.

In the case of the mothers, an interview was conducted, with an interpreter if necessary. The researcher wrote down their answers on the questionnaire as they spoke. Emotions expressed by the mothers were also written down. (See Appendix E)

For the nursing personnel and doctors the researcher gave the consent forms and questionnaires to the participants to fill in by themselves. It is written in 2 languages, since all the personnel were Afrikaans. (See Appendix E)

Answers to questions in the different groups:

Group A: Mothers

Five of the mothers agreed to participate in the questionnaire. (Since this part of the study was conducted towards the end of the SG, only the last 5 mothers could be interviewed.) One of the mothers needed an interpreter. In all the cases the researcher did the interview

while writing the mother's answer and making notes of emotions she expressed during the questioning.

Question 1: Were you informed that your baby needed CPAP before it was started?

Four of the 5 mothers reported that they were not informed that their babies needed nCPAP. It was started without discussing the need with the mothers.

Question 2: Was the reason for starting CPAP explained to you at any stage?

Three of the mothers said that at some stage after birth, one of the health personnel explained the reason for starting nCPAP to her.

Question 3: Was CPAP (the way it works) explained to you at any stage?

Four of the mothers answered "no" to the question.

Question 4: How did you feel when you first saw your baby with the CPAP applied?

Three of the mothers was clearly emotional at this stage. Two started crying. They answered as follows: "I did not feel well", "I was sad and worried" and "I was scared that my baby was going to die." One mother said that she was stressed by seeing the baby, but not worried. The 5th mother said that the baby will just have to take it to get better. She did not seem concerned.

Question 5: Did you feel that it helped your baby? Why?

Only 2 of the mothers had an answer to the question.

They answered as follows:

- "The baby couldn't breathe on its own, and the machine helped her."
- "She (the baby) would have died."

Group B: Nursing Personnel

Seventeen of the nursing staff agreed to take part. This included 6 PN's, 4 staff-nurses and 7 nurses and this represented all the nursing staff involved with CPAP covering all the shifts (2 day and 2 night-shifts). No distinction was made between the PN, staff nurses and nurses when they answered the questions, since the researcher felt that all were asked (in the current system) to work in the neonatal unit with CPAP neonates.

Question 1: What is your role in connection to the care of the neonate? *Wat is jou rol t.o.v. die sorg van die neonaat?*

Doctor/Dokter

Nursing Personnel/ Verpleegpersoneellid All answered "YES".

Question 2: Did you receive any training on CPAP, what type of training? (e.g. workshop/none/taught by other member of personnel) *Het jy opleiding ontvang om CPAP toe te pas, indien wel watter tipe opleiding? (bv werkswinkel/geen/deur medewerker geleer?)*

- 1 had no training.
- 11 were trained by colleagues.
- 5 attended the initial training workshop.

Question 3: Have you started CPAP by yourself or worked with someone to apply CPAP or given orders to start CPAP for a baby? *Het jy al self CPAP begin /of saam met 'n kollega dit begin /of bevele gegee dat dit begin word?*

- 7 have started nCPAP by themselves. (4 of them were in the group that attended the initial workshop.)
- 8 have started nCPAP with a colleague (had assistance).
- 2 have never initiated nCPAP. (1 of them answered “no training” in question 2.)

Question 4: Do you feel comfortable to start CPAP by yourself? (Score yourself between 1 and 10 with 1 not comfortable at all and 10, totally comfortable.) *Voel jy gemaklik om CPAP self te begin vir 'n neonat? (Bepunt jouself tussen 1 en 10, met 1 as totaal ongemaklik en 10 as baie gemaklik.)*

6.9 average

1 2 3 4 5 6 ↑ 7 8 9 10

Table 9: Results of self scoring

Nr of Medical personnel	Scored by themselves
7	10/10 (of which 4 attended the initial workshop)
2	8/10
1	6/10
4	5/10
1	4/10
2	1/10
Total: 17	Average 6.9/10

Question 5: Do you feel that CPAP works? Is it making a difference to the outcome of the babies? Why? Voel u dat CPAP werk? Maak dit 'n verskil in die uitkoms van die neonate? Waarom?

All 17 answered that “Yes” it works and “Yes” it makes a difference. (5 used the word “absolutely” in place of “Yes”.)

Here are the quotes of those that gave further comment as to why they thought nCPAP worked (translated from Afrikaans comments):

- “Most babies have better chances of surviving with CPAP. Babies less than 800g the chances are 50/50.”
- “It [CPAP] makes a difference, especially if started early.”
- “Treatment can be started immediately (at Ceres Hospital), with no delays to first transfer baby via ambulance. Less deaths.”
- “Fewer babies need transfer to referral hospitals. If baby needs transfer, he can still be treated with nCPAP while waiting. Fewer babies die.”
- “CPAP improves baby’s whole condition.”
- “I have seen over time that it helps the neonates with respiratory distress. It improves their condition. Less transfers to referral hospitals.”
- “Less transfers. CPAP treatment can be started immediately. More babies survive on CPAP.”
- “CPAP works. Babies on CPAP usually survive or have a better chance of survival.”
- “Many babies can be saved with CPAP.”
- “We can start treatment sooner. Not all babies need transfer to Worcester (hospital).”
- “It [CPAP] can save many babies. Especially babies with rib-retraction and those that need O2 therapy.”

Group C: Doctors

All 5 government-employed doctors that work permanently at Ceres Hospital (except the researcher) and all 4 of the private doctors that do sessions at Ceres Hospital (and thus comes into contact with nCPAP), took part in the questionnaire. Thus, all doctors were interviewed. Responses were as follows:

Question 1: What is your role in connection to the care of the neonate? Wat is jou rol t.o.v. die sorg van die neonaat?

Doctor/DokterAll answered Yes

Nursing Personnel/ Verpleegpersoneelid

Question 2: Did you receive any training on CPAP, what type of training? (e.g. workshop/none/taught by other member of personnel) *Het jy opleiding ontvang om CPAP toe te pas, indien wel watter tipe opleiding? (bv werkwinkel/geen/deur medewerker geleer?)*

- Government Doctors: 4 x “taught by another member of staff”, 1 x attended workshop
- GP Doctors: 2 x no training, 1 x “taught by other member of staff”, 1 x attended workshop

Question 3: Have you started CPAP by yourself or worked with someone to apply CPAP or given orders to start CPAP for a baby? *Het jy al self CPAP begin /of saam met ‘n kollega dit begin /of bevele gegee dat dit begin word?*

- Government Doctors: 3 x started nCPAP with a colleague, 2 x started it themselves
- GP Doctors: All “gave orders to start nCPAP” (none started it themselves)

Question 4: Do you feel comfortable to start CPAP by yourself? (Score yourself between 1 and 10 with 1 not comfortable at all and 10, totally comfortable.) *Voel jy gemaklik om CPAP self te begin vir ‘n neonat? (Bepunt jouself tussen 1 en 10, met 1 as totaal ongemaklik en 10 as baie gemaklik.)*

- Government doctors: Scored themselves 5,6,8,9,10 (Average = 7.6)
- GP doctors: Scored themselves 1,1,1,5 (Average = 2)

Question 5: Do you feel that CPAP works? Is it making a difference to the outcome of the babies? Why? *Voel u dat CPAP werk? Maak dit ‘n verskil in die uitkoms van die neonate? Waarom?*

- Government doctors:
 - Most babies do better within one day.
 - Small input, big difference in outcome.
 - Much less referrals.
 - Does work.
 - Neonatal outcome increases if used in indicated cases.
- GP doctors:
 - Helps with babies in respiratory distress.
 - According to data, it works well in all babies with respiratory distress.
 - Neonates on CPAP have good outcomes.
 - It definitely makes a difference in the outcome of neonates.

v. Description of CPAP Process at Ceres Hospital

The CPAP program at Ceres Hospital was initiated by the Neonatal unit at Tygerberg Hospital (the tertiary referral hospital). The type of CPAP machine was decided by them as well. Worcester Hospital was bypassed in the implementation process, since it was an experiment to see if CPAP can be practiced in the rural setting.

The doctors and nursing personnel were all taught the principles of CPAP. No indication was given as to who should be responsible for which part of the CPAP process. Over time it developed at Ceres Hospital that the nursing personnel were responsible for the practical application of CPAP, and the doctors made the decisions when to start, wean and terminate CPAP.

Only one CPAP workshop was held right at the beginning of the program. After that all new personnel that had to work in the labour ward, were taught by colleagues.

11. Discussion

The discussion will be done under the following headings:

- i. Analysis of CPAP findings.
- ii. The effect of CPAP on survival and referrals of neonates.
- iii. Discussion of semi-structured interviews.
- iv. Introduction of CPAP program at a rural hospital.

i. Analysis of CPAP findings

Through documenting the information on every CPAP case, some findings were made that supports existing literature. These findings will now be explored:

- The main bulk of CPAP cases came from the <1800g weight group: 34 cases. In comparison only 17 cases came from the >1800g group. This can be explained by the higher risk for developing HMD with increased prematurity (due to lack of surfactant), and thereby the increased need for CPAP.
- Resuscitation before CPAP initiation were more commonly needed in the >1800g group (59%) than in the <1800g group (38%).
- Mean age at initiation of CPAP was shortest in the 1000-1500g group (1.7 hours).
- Mean duration of CPAP got progressively shorter with increase in weight: 51 hours in the <1000g neonates, 27 hours in the 1000g-1500g group, 14 hours in the 1500g-1800g group and 13 hours in the >1800g neonates.
- At Ceres Hospital a total of 1343.5 hours of CPAP were given over the two-year period. Eighty three percent (83%) of this time was spent on CPAP for <1800g neonates.
- The smaller the weight of the neonate, the higher was the risk of CPAP failure. 70% of neonates <1000g failed on CPAP. In the <1800g neonates all failures were associated with some degree of HMD. In the >1000g group, HMD were commonly accompanied by cardiac lesions. As expected, failure in the >1800g group were never caused by HMD, since surfactant production in these neonates are usually complete.

ii. The effect of CPAP on survival and referrals of neonates

One of the aims of this study was to see what the effect of CPAP was on survival and transfer rates between the SG (with CPAP) and HCG (with no CPAP).

The study found that the **survival rate** between the SG and HCG showed no statistically significant difference, with a p-value = 0.5490. In other words, the CPAP process at Ceres

Hospital appears not to have made a significant impact on survival. The researcher explains this with the following arguments:

- If CPAP is used as a treatment modality at a rural hospital, neonates that suffer from respiratory distress will be treated. These neonates were previously, during the time of the HCG, sent to referral hospitals, effectively lowering the risk of early or late neonatal deaths at the rural hospital. By keeping the neonate with respiratory distress at the rural hospital and treating it with CPAP, the hospital treats higher risk neonates. Seen in this light, no difference in survival rate is a positive outcome and should rather be formulated as “no increase in mortality, even though higher risk infants were treated”.
- During the period that CPAP was available at Ceres Hospital, the obstetricians at the referral hospital, under pressure of limited beds, decided not to accept women in premature labour that stood a reasonable risk of delivering severely premature babies, since CPAP were available at Ceres Hospital. In the past (during the time of the HCG) they accepted these patients, since it was viewed as better practice to transfer the foetus intra-uterine and have a paediatrician available at the referral hospital, than to deliver the baby at the rural hospital and risk mortality and morbidity due to complications associated with prematurity. This transferred a higher risk from the referral hospital to the rural hospital.
- Another change seen after the introduction of CPAP at Ceres Hospital, was that the obstetricians at the referral hospitals would send high risk obstetric patients to the rural hospital for induction and delivery, that previously would have been delivered at the referral hospital. An example of this is women with high resistance indexes on Doppler due to hypertension, with babies < 36 week gestation. The risks of respiratory distress suffered by neonate from these patients are higher. Again, risk is transferred to the rural hospital.
- During the time that CPAP was available at Ceres Hospital, severe shortages of beds at referral hospitals were experienced. In these instances, neonates could not be accepted at referral hospitals due to the lack of available beds. This contributed to higher mortality rates during the CPAP period.

The effect of CPAP on neonatal **transfer rates** from Ceres Hospital to referral hospitals, was found to be statistically significant in this study (p-value = 0.0003). Referrals decreased from 21.05% of neonates in the HCG, to 6.75% in the SG.

From these findings it can be concluded that the introduction of CPAP at Ceres Hospital, a rural district hospital, have been shown to lower transfer rates significantly, resulting in decreased pressure on referral hospitals and significant cost savings in transfers, with no increase in neonatal mortality rates, even though a higher risk population was treated.

In the study by Koyamaibole et al, it was found that the introduction of CPAP at a referral hospital (in Fiji) with specialist paediatricians, reduced the need for mechanical ventilation by 50% (from 113/1106 prior to CPAP to 70/1382 after CPAP), but had no influence on the mortality rate³. This correlates with the findings in this study.

iii. Discussion of semi-structured interviews

Discussion on interviews with mothers:

The main aim of this questionnaire was to test communication between the health personnel and the patients/mothers. It is ethically correct to discuss treatment of the neonate with the mother and thereby to help her to be part of the decision-making process. We also know in theory that if the process is explained to the mother as it goes along, we give her some control in it, suppressing her fears and lowering anxiety.

This is well demonstrated in the 5 mothers that were interviewed. The only mother that answered “yes” in question 1,2 and 3, also showed no emotional anxiety in question 4 and had an answer in question 5 (“The baby couldn’t breathe on its own, and the machine helped her”) that reflected insight in the situation.

The importance of good communication between health personnel and patients is thus demonstrated, and personnel should be trained to always make the babies’ parents part of the process.

Discussion on the questionnaire filled in by nursing personnel involved in the CPAP program:

There is a very positive attitude among nursing personnel towards nCPAP. None of them had negative comments. They all gave the impression that, even though some of them did not feel comfortable to initiate nCPAP by themselves, they fully support the use of nCPAP in the neonatal unit.

Only 5 out of the 17 (29%) attended the initial workshop. They were the ones that were more comfortable to initiate nCPAP by themselves and supported the others that reported that they have only started nCPAP with the “assistance of a colleague”.

The average “confidence” in the use of nCPAP is relatively high, with 6.9/10 the average score among nursing personnel. Seven respondents scored themselves 10/10 and 2 scored themselves 1/10.

The last question examined the opinion of the nursing staff towards nCPAP. It was very positive, notably also from the personnel that reported no confidence in applying nCPAP themselves.

Their reasoning as to why they thought CPAP worked, focused on the following themes:

- Survival is better.
- Treatment can start as soon as respiratory problems are noticed.
- Fewer transfers to referral hospitals.

Discussion on the questionnaire filled in by doctors involved in the CPAP program:

Only 2 of the doctors attended the initial workshop on nCPAP. The rest were taught by other members of staff or had no training whatsoever.

The government doctors report good ability to initiate nCPAP themselves. The GP's all reported that they "gave orders to initiate nCPAP". This is important to note, since it tells us that the practical training in applying nCPAP must be focused on the PN's, since they most likely are the ones that will have to initiate CPAP.

The hospital doctors report a much higher confidence in applying nCPAP (average 7.6/10) in comparison to the GP's average of 2/10.

Taking all into account it seems that the doctors view the practical application of nCPAP in the neonate as the job of the nursing personnel and their own function limited to the decision-making process (for instance, when to start nCPAP, changes to settings and when to stop nCPAP).

All the doctors felt that nCPAP makes a difference to the outcome of neonates. Only one commented on the decrease in transfers to referral hospitals.

iv. Introduction of CPAP program at a rural hospital.

Rural hospitals that introduce a CPAP program into their neonatal care unit, need to follow certain steps to guarantee best results from this treatment modality. Questions that need to be answered are:

- Is the referral hospital (that will accept patients from the rural hospital) involved in the acquiring of CPAP machines and training of rural staff?
- What CPAP machine to use?
- Who needs to be trained?
- How long to train?
- What need to be in the training manual?

The involvement of the referral hospital in the process of introducing a CPAP program at a rural hospital, seems to be of great value. If this introduction is driven by the tertiary hospital, bypassing the secondary/referral hospital, a link in the chain is missed. The referral hospital needs to know exactly what the capabilities are at the rural hospital: from type of CPAP machines to knowledge and clinical ability of staff. This knowledge will be gained if they are involved in the training process.

The type of CPAP machine should be suggested by the referral hospital. The researcher would suggest (in the light of the literature reviewed) that it need not be ventilator driven or even have ventilator capability ⁶. A simple CPAP machine with all the basic components is acceptable. The basic components are a flow generator: O₂ supply, medical air supply, air-O₂ blender, flow and pressure meters, humidifier. The hose: can be dispensable or re-usable. The interface: bi-nasal prongs is best, as suggested by the literature reviewed ¹.

All the personnel involved in neonatal care should be included in the training. This includes nurses, staff-nurses and PN's as well as all the doctors that have contact with neonates. Training should be made compulsory and time should be made available for staff to attend. This may imply the organising of locums to leave the doctors free to attend and two workshops so that nursing personnel from all shifts can attend.

Training can be done in a 4-hour workshop that must include a theoretical as well as a practical aspect. The workshop instructors should include doctors and nursing staff. After the workshop, a training manual must be available in the neonatal unit.

12. Recommendations

Recommendations will be discussed under the following headings:

- i. Protocols for CPAP in rural hospitals.
- ii. Job descriptions for nursing personnel and doctors.
- iii. Maintenance of CPAP knowledge.
- iv. Monitoring of CPAP program.
- v. Surfactant use at district hospital level
- vi. Extension of CPAP to non-neonates.

i. Protocols for CPAP in rural hospitals

Protocols should be available in the neonatal unit when CPAP is introduced. These protocols should give guidance to the nursing personnel on how to react to situations and when to call the doctor.

An example would be the SaO₂ readings that are continuously being taken on the neonate. The sister should be able to look at the protocol, and adapt the air- O₂ blender accordingly.

Table 10: CPAP Protocols: Saturation Monitoring

Patient			Alarm	Limits
Birth Weight	Gestation (Weeks)	SaO ₂	Lower	Upper
<1500g	< 32 weeks (corrected)	85%-90%	84%	91%
>1500g	32-35 weeks (corrected)	88%-92%	87%	93%
	>36 weeks (corrected)	90%-95%	89%	96%

Another important protocol that is needed, is the guideline on which neonates qualify for CPAP. In this study the smallest neonate that was successfully managed with CPAP, was 820g at birth. None of the smaller neonates was successfully treated with CPAP due to their degree of respiratory distress. No referral hospital currently accepts < 800g neonates, and no surfactant is available at the rural hospital. Therefore it would be reasonable to say that < 800g neonates do not qualify for CPAP. The referral hospital should be consulted in this protocol.

ii. Job descriptions for nursing personnel and doctors

At the onset of a new CPAP program, the responsibilities of all the health personnel involved should be stipulated. A common area of conflict in Ceres Hospital is what the doctors should do him/herself and what s/he can order to be done. This problem started due to the involvement of general practitioners in doing calls at the hospital, but not having the skills to apply the CPAP themselves. They then rely on the PNs to do the application of CPAP. The nursing personnel feel that they are then functioning on a level they are not trained for or remunerated for.

iii. Maintenance of CPAP knowledge

CPAP training should be repeated on a yearly basis. Due to the frequent change in health personnel in the government sector, especially with community service for doctors and PNs only working for one year in a hospital, the skills and knowledge should be updated to new personnel on a yearly basis.

iv. Monitoring of CPAP program

The information on all neonates that receive CPAP should be entered on the “CPAP log-sheet”. (See appendix C) This should be kept for monitoring purposes.

All deaths of neonates that received CPAP should be discussed at monthly mortality and morbidity meetings. This can be done by the obstetrician when PPIP data are reviewed (since all neonatal deaths are captured on PPIP data, and not ChildPIP), but ideally a paediatrician should be present during these meetings.

[At Ceres Hospital, the visiting obstetrician in the outreach and support program visits the hospital on a monthly basis and all neonatal deaths are discussed.]

v. Surfactant use at district hospital level

CPAP as the only treatment modality for respiratory distress in neonates, has been shown to be effective in mild to moderate forms of respiratory distress ⁶. The next step in treatment, if CPAP is not effective on its own and the cause is HMD, is to give surfactant. In this study it was the case in all the premature infants <1800g that were transferred to regional hospitals.

The problem in rural hospitals is that surfactant is not on the pharmaceutical code list for rural hospitals. In the Provincial Code List for the Western Cape, surfactant is restricted to

“Neonatal ICU and High Care” with comment: “For use in selected pre-term infants between 700 and 1000g body weight”¹⁰. As a result, neonates that need a FIO₂ of 60% or more, have to be referred to regional hospitals for surfactant, usually after intubation and ventilation, with a high mortality and morbidity.

It would seem that the next logical step would be to supply rural hospitals with surfactant and thereby treat even more neonates at the rural setting, lowering morbidity and mortality, saving the cost of transport and relieving pressure on regional hospitals. Another perspective would be that CPAP and surfactant are both used in the treatment of respiratory distress of the neonate and if CPAP is implemented at a hospital, surfactant should also be made available.

Important to note here is that some training should be done at the rural hospital on how to give surfactant to the neonate. Most rural hospitals now have experienced medical officers that have the skills needed to give surfactant.

vi. Extension of CPAP to non-neonates

When CPAP is introduced into neonatal care at a hospital, it implies that the hospital has a medical air compressor (dry loop compressor) that can deliver air to the O₂-air blender for use in CPAP. Once this is in place, CPAP can be used at all points where medical air and O₂ points are available. The CPAP can then be extended to treatment of infants, children and adults, if medically indicated. Again this will lead to savings in cost of transfers and relieve pressure on referral hospitals.

13. Conclusion

CPAP presented a simpler and cheaper alternative in the treatment of mild to moderate respiratory distress in neonates, significantly reducing the need for intubation, ventilation and transfer to regional hospitals with no significant change in mortality.

The findings were comparable to existing literature on the subject ³.

Nursing and medical staff quickly became proficient and confident in applying CPAP and were committed to the project, with unanimous support shown in the questionnaires.

14. References

- (1) De Paoli AG, Marley C, Davids PG. Nasal CPAP for neonates: What we know in 2003. Arch Dis Child Foetal Neonatal Ed. 2003;88:F168-F172.
- (2) Gustavo P, Mohamed AA, Shoo KL. Nasal continuous positive airway pressure and outcomes in preterm infants: A retrospective analysis. Paediatr Child Health.2008 Feb;13(2):99-103.
- (3) Koyamaibole L, Kodo J, Qovu DJ, Colquhoun S, Duke T. An evaluation of bubble-CPAP in a neonatal unit in a developing country: Effective respiratory support that can be applied by nurses. J Trop Peadr.2005 Dec; 205;52(4):249-253.
- (4) Norendran V, Donovan F, Hoath B, Akinbi T, Steichen j, Jobe H. Early bubble CPAP and outcomes in ELBW preterm infants. J Perinatology. 2003 May;23(3):195-199
- (5) Courtney SE, Kahn DJ, Singh R, Habib RH. Bubble and ventilator-derived nasal continuous positive airway pressure in premature infants: work of breathing and gas exchange. J Perinatol. 2010 April;15:1-7
- (6) Tagare A, Kadam S, Vaitya U, Pandit A, Patole S. A pilot study of BCPAP vs. VCPAP in preterm infants with early onset respiratory distress. J Trop Pediatr. 2010 Jun;56(3) 191-194
- (7) Groenewald P, Bradshaw D, Krige F, Van Niekerk M, Champion F, Karsten T, Verwey G, Van der Merwe W. Causes of death and premature mortality in the Cape Winelands and Overberg Districts 2004-2006. www.mrc.ac.za/bod/bod.htm.
- (8) Witzenberg Integrated Developmental Plan 2007/2011.
- (9) Perinatal Problem Identification Program (PPIP) version 2.2.3, National Databank.
- (10) Provincial Code List : Catalogue of Approved Pharmaceuticals for use in the Department of Health

15. Appendices

Appendix A: PPIP data

Attached as Excel file

Appendix B: <1800g register

Attached as Excel file

Appendix C: CPAP log-sheet

1

Inligtings vorm vir babas behandel met nasale CPAP
Ceres Hospitaal

Naam..... Graviteit & pariteit.....
 Ouderdom:..... Bespreek: Ja/Nee.....
 Antenatale steroiede: Ja/Nee Dosis en aantal toedienings.....
 Hoelank voor verlossing toegedien.....
 Roete van erlossing.....
 Hipertensie.....Pre-eklampsie.....HELPP sindroom.....
 Abruptio placentae.....VDRL.....
 Ander komplikasies.....

 Naam van baba.....
 Hospitaal nommer:..... Datum van geboorte.....
 Geslag:..... Gestasie:..... Massa.....
 Apgar telling 1 min,5 min.....10 min.....
 Resussitasie: Nee/Ja
 Indien Ja, beskryf resussitasie benodig.....

 Neopuff gebruik:.....Ambubag gebruik:.....
 Hoe gou na geboorte is baba op CPAP geplaas?.....
 Hoe lank het baba nCPAP benodig (ure).....
 Wt was die hoogste suurstof konsentrasie benodig tydens nCPAP.....
 Het die baba enige antibiotika ontvang?.....
 Watter antibiotika?.....
 Indikasie vir antibiotika.....

 Het nCPAP gefaal?.....
 Moes baba intubeer word.....
 Is baba oorgeplaas en na waar.....
 Komplikasie van nCPAP; Pneumotoraks, neus nekrose ens.....

Appendix D: CPAP case data

Attached as Excel file (sheet one: information on neonates; sheet four: information on mothers)

Appendix E: Interview Questionnaires for mothers and health personnel

nCPAP Questionnaire:

Mothers

1. Were you informed that your baby needed CPAP before it was started?

Yes No

2. Was the reason for starting CPAP explained to you at any stage?

Yes No

3. Was CPAP (the way it works) explained to you at any stage?

Yes No

4. How did you feel when you first saw your baby with the CPAP applied?

.....
.....

5. Did you feel that it helped your baby? Why?

Yes No

.....
.....
.....

nCPAP Questionnaire/CPAP Vraelys:

April 2010

Health personnel/Gesondheidspersoneel

1. What is your role in connection to the care of the neonate? ***Wat is jou rol t.o.v. die sorg van die neonaat?***

Doctor/***Dokter***

Nursing Personnel/ ***Verpleegpersoneel***

2. Did you receive any training on CPAP, what type of training? (e.g. workshop/none/taught by other member of personnel) ***Het jy opleiding ontvang om CPAP toe te pas, indien wel watter tipe opleiding? (bv werkswinkel/geen/deur medewerker geleer?)***

.....

3. Have you started CPAP by yourself or worked with someone to apply CPAP or given orders to start CPAP for a baby? ***Het jy al self CPAP begin /of saam met 'n kollega dit begin /of bevele gegee dat dit begin word?***

4. Do you feel comfortable to start CPAP by yourself? (Score yourself between 1 and 10 with 1 not comfortable at all and 10, totally comfortable.) ***Voel jy gemaklik om CPAP self te begin vir 'n neonaat? (Bepunt jouself tussen 1 en 10, met 1 as totaal ongemaklik en 10 as baie gemaklik.)***

1 2 3 4 5 6 7 8 9 10

5. Do you feel that CPAP works? Is it making a difference to the outcome of the babies? Why? ***Voel u dat CPAP werk? Maak dit 'n verskil in die uitkoms van die neonate?***

Waarom?.....

.....

.....

.....