Niger J Paed 2013; 40 (3): 275 –277

ORIGINAL

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Customized bubble continuous positive airway pressure (BCPAP) device at the National Hospital Abuja for the treatment of respiratory distress syndrome (RDS)

DOI:http://dx.doi.org/10.4314/njp.v40i3,14
Accepted: 9th February 2013

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Abstract Using the principle of under-water-seal pressure, we assembled a circuit to produce an effective Bubble Continuous Positive Airway Pressure device at the National Hospital. The device is reasonably inexpensive and is suitable for use at secondary and tertiary health institutions for the care of the preterm infant with RDS.

Introduction

Prematurity is a major cause of neonatal deaths in developing Countries.[1-2] It accounts for 25% of neonatal deaths in Nigeria.[3] Respiratory distress resulting from surfactant deficiency accounts for a significant proportion of deaths among preterm babies globally.[4] Invasive respiratory support is fraught with several short and long term complications including pneumothorax and brochopulmonary dysplasia[5] Its application is capital intensive and also requires specialized technical support which limits its use in most resource poor countries.
Prematurity is a major cause of neonatal deaths particularly in developing countries.[1-2,3] A significant proportion of preterm deaths worldwide are caused by respiratory illnesses requiring assisted ventilation.[4] Traditionally, respiratory support is invasive and is fraught with several short and long term complications including pneumothorax and brochopulmonary dysplasia.[5] Its application is capital intensive and also requires specialized technical support which limits its use in most resource poor countries. There is currently, a global shift towards the use of non invasive respiratory support for preterm babies with RDS, the hallmark of which is the application of continuous positive airway pressure (CPAP). [6-7] The benefits of CPAP in the management of respiratory distress syndrome are well documented[8-10].

Different devices are used for the delivery of CPAP including conventional ventilators, variable-flow infant CPAP and the Bubble CPAP. The essential components of a CPAP device include a pressure generator, the CPAP circuit and airway interface.[11] Bubble CPAP has an edge over the others because it is cheap and easy to apply. Its superiority over ventilator-derived CPAP in the management of preterm infants with RDS was demonstrated by Bahman-Bijari et al[12]. In Bubble CPAP, an oscillatory pressure is generated by the flow of gas through an under-water seal system. In addition to the pressure generated, mechanical vibrations similar to those of high frequency ventilation are transmitted to the chest.

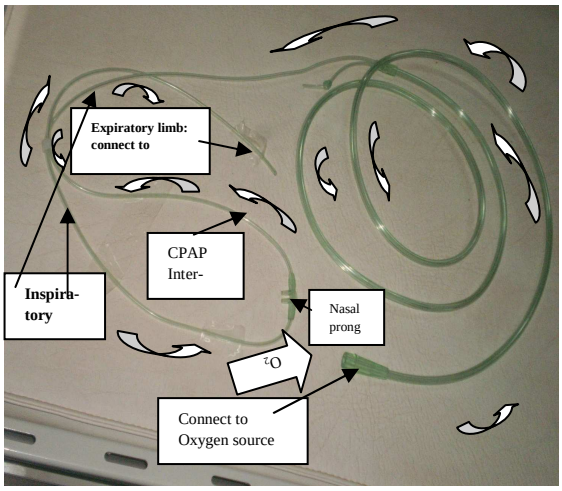
Commercially available Bubble CPAP devices are quite expensive and most health institutions in resource constrained countries may not be able to afford them. The effectiveness of locally adapted Bubble CPAP devices has been documented[14]. To meet the increasing demand for a simple respiratory support for preterm babies in our institution, we modified the existing Bubble CPAP devise using readily available but far less expensive materials. The resultant product is cheap, easily assembled and can be applied by both doctors and nurses after a short training. The aim of this initial communication is to describe the devise which can be used in both tertiary and secondary health institutions in the management of RDS with the ultimate goal of reducing neonatal mortality in the country.

Materials and Methods

The infant oxygen delivery tubes with binasal prongs (manufactured by Jiangsu Yada Technology Group Co Ltd China, fig 1) essentially serve as the CPAP circuit, providing the inspiratory limb, the interface (nasal prongs) and the proximal part of the expiratory

limb. The proximal end of the inspiratory limb connects the humidified oxygen source (oxygen cylinder, oxygen concentrator or wall-piped oxygen) through the interface to the baby. It is interesting to note that these tubes are available in most tertiary institutions where they are traditionally used to deliver intranasal oxygen to infants in the neonatal and paediatric wards.

Fig 1: CPAP circuit (oxygen delivery tube)



The nasal prong (which is a component of the oxygen delivery tube) comes in different sizes. It is firmly applied to the nostrils by gently adjusting the strap around the baby's head. These prongs are soft and therefore do not cause pressure induced ischaemic damage to the nasal septum as reported with the nasal prongs that come with commercially available CPAP devices. The CPAP generator is a cylindrical, transparent bottle filled to predetermined level with distilled water. The expiratory limb of the circuit is immersed in this bottle and the depth of immersion in centimeters below the water surface corresponds to the desired CPAP in cmH_20.
The tube is carefully secured with an adhesive plaster to ensure that the length immersed in water remains constant. Figs 2 and 3 show the assembled device.

Fig 2: Components of the bubble cpap device

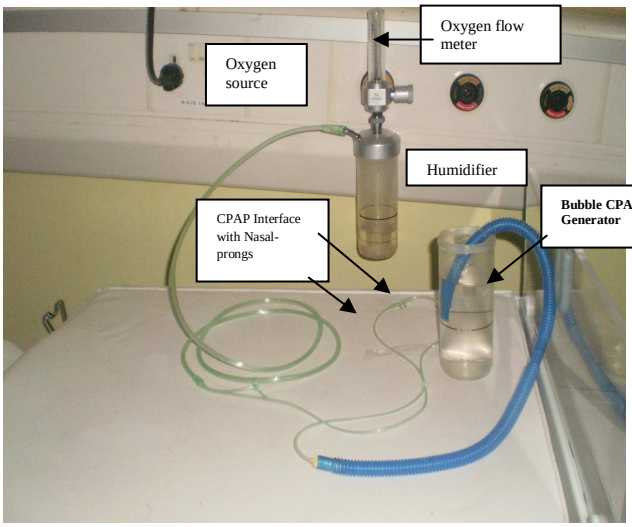
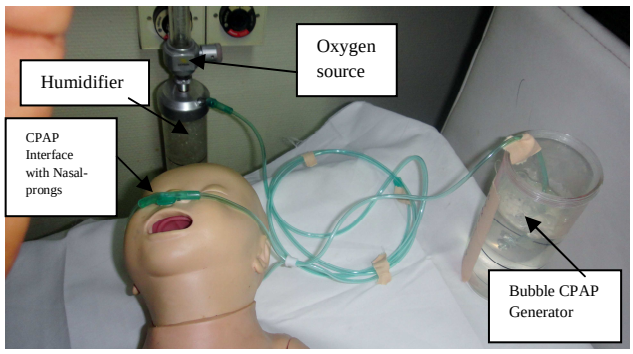


Fig 3: Shows the set –up of the bubble cpap



With the oxygen flow rate set at 6-8l/min and the expiratory limb of the tube immersed to a depth of 5cm, bubbles are immediately generated. Chest auscultation is essential to confirm presence of bubbling sounds; its absence may suggest a leak along the tubing or at the interface (nasal prongs) or that the baby's mouth is open
The initial response includes a significant improvement in the SPO_2 and a noticeable reduction in the baby's work of breathing. It is important to pass a nasogastric tube for intermittent gastric decompression to take care of attendant gaseous distension.
This has been in use since November 2011 in the newborn unit of our hospital for preterm babies with respiratory distress syndrome. A total of 89 babies most of whom were preterm, very low birth weight with respiratory distress syndrome have been treated with this device.

Conclusion

This is a simple and easily affordable technology that promises to save the lives of preterm babies with the ultimate goal of reducing neonatal mortality in our subregion. The average cost of the disposable components of the device is N2, 000 ($12). The average cost of providing the consumables for the nasal flow CPAP (corrugated tubes, nasal prongs, head caps) is about N8, 000($48=) per patient. Another major advantage of our devise is that the nasal prongs are soft and do not cause ischaemic damage to the nasal septum.

Authors' Contributions
Audu LI, Otuneye AT: Conceptualization and design of the device and Manuscript write-up
Mukhtar MY, Mairami AB, Mshelia LJ, Garu M proof reading and editing of manuscript.
Conflict of interests: None
Funding: National Hospital Abuja

Acknowledgement

We are grateful to Professor Dawodu A and Dr Akinbi H both of the Cincinnati Children's Hospital and Medical Center, Ohio, USA for initiating the use of non-invasive ventilation in our newborn Unit.

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