African Journal of Emergency Medicine 10 (2020) 281–283

Contents lists available at ScienceDirect

African Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/afjem

Case report

Successful use of an improvised bubble CPAP device for severe respiratory distress caused by pulmonary tuberculosis

Tabitha Nadishani Meyer[a], Gareth Dudley Meyer[a,*], Hans Jurgen Hendriks[a,b]

[a] Zithulele Hospital, Mqanduli, South Africa
[b] Department of Family Medicine, Walter Sisulu University, South Africa

ARTICLE INFO

Keywords:
Respiratory distress
Severe pneumonia
CPAP
Low resource setting
Non-invasive ventilation

ABSTRACT

Introduction: This case report discusses the successful use of an improvised bubble continuous positive airway pressure (CPAP) apparatus made using items commonly available in a poorly resourced district hospital.
Case presentation: A 64-year-old female with no co-morbidities presented with respiratory failure due to pulmonary tuberculosis and was not accepted into the regional Intensive Care Unit (ICU) on referral. She required 8 days of improvised bubble CPAP to maintain adequate oxygen saturation before weaning and eventual discharge.
Discussion: Improvised bubble CPAP is commonly used in neonatal care in developing countries and well described in literature however, there are no reports of its successful use in adult patients. In the absence of access to ICU or other Non-invasive ventilation (NIV) equipment, improvised bubble CPAP may provide some therapeutic benefit.

African relevance

- Africa has high rates of severe pneumonia due to high prevalence of HIV and tuberculosis.
- There are many low resource health facilities with poor access to both invasive and non-invasive ventilatory support.
- Long wait times and distances to Intensive Care Units necessitate short term ventilatory support or salvage theray for patients with severe respiratory distress.
- Items commonly available in low resource settings were utilised to construct the aparatus.

Introduction

Acute Respiratory distress from bilateral diffuse infiltrates is a common presentation in South Africa due to the burden of HIV and Tuberculosis. Limited access to intensive care within the overburdened public health sector results in strict exclusion criteria or insufficient capacity. The availability of non-invasive ventilation equipment such as high flow nasal cannulae or ventilators with CPAP capabilities sadly mirrors the lack of access to ICU. These factors mean that in reality these patients are often managed expectantly. Improvised bubble CPAP is a well-documented practice for paediatric, and in particular neonatal, respiratory distress in developing countries [1,2]. A report of an improvised bubble CPAP for adults trialled on healthy participants has previously been published, however no report on use within a clinical setting was found during the literature search [3].

Case presentation

A 64-year-old female from rural South Africa presented to her local district hospital with a two-day history of progressive shortness of breath preceded by two weeks of fever and cough. No co-morbidities or notable previous medical or surgical history were noted on history. She had marked respiratory distress with an oxygen saturation of 60% in room air and a respiratory rate of 45 bpm. Oxygen saturation improved to 70% on a non-rebreather mask at 15 l of oxygen per minute. Despite marked distress she was not confused. There were no clinical signs of cardiac failure. Diffuse bilateral infiltrates were noted on X-ray (Fig. 1) and the patient was admitted on intravenous ceftriaxone to cover for bacterial pneumonia as well as high dose Co-trimoxazole and oral prednisone to cover for pneumocystis pneumonia while awaiting HIV Elisa result. Laboratory testing showed normal renal function, a hyponatraemia of 129 mmol/l, and a haemoglobin level of 9.2 mg/dl. Rapid HIV test was negative. No arterial blood gas testing was available. No ventilator or non-invasive ventilation equipment was available at the institution and there were no available beds at the referral hospital. Despite maximal conservative management she was deemed to have an

* Corresponding author at: Zithulele Hospital, Mqanduli, South Africa.
E-mail address: gazmeyer@googlemail.com (G.D. Meyer).

https://doi.org/10.1016/j.afjem.2020.06.013
Received 16 May 2020; Received in revised form 24 June 2020; Accepted 24 June 2020
Available online 10 July 2020

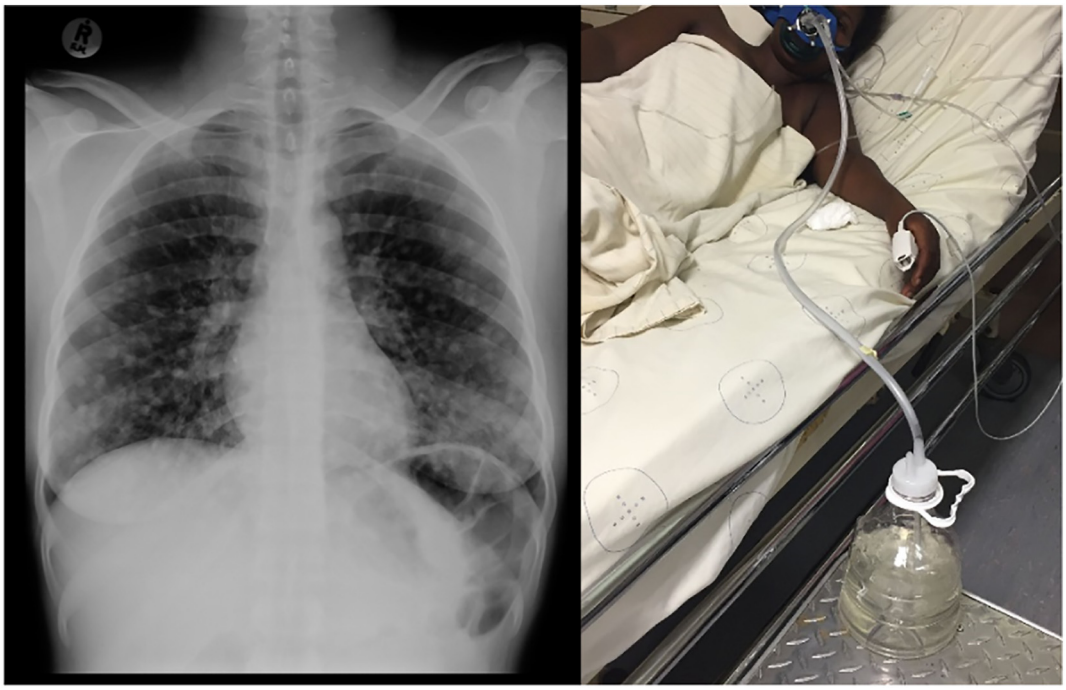

Fig. 1. Chest X-ray and patient with improvised bubble CPAP.

extremely poor prognosis by the managing doctors. With the consent of the patient an improvised bubble CPAP apparatus was constructed to temporarily assist with ventilation until a High care or ICU bed became available (Fig. 1). Marked improvement in oxygen saturation to 95% as well as a reduction in distress and respiratory rate was noted within 30 min of commencing the CPAP. On day two of admission sputum results returned confirming rifampicin sensitive *Mycobacterium tuberculosis* and HIV serology was negative. Co-trimoxazole was stopped and treatment for tuberculosis commenced, steroids and ceftriaxone were continued. Continuous CPAP was provided to maintain an acceptable oxygen saturation over the next eight days with daily attempts to wean and daily discussions with the tertiary centre awaiting a bed. The improvised CPAP apparatus was only removed during meals and for oral medication which resulted in a marked drop in oxygen saturation. In lieu of arterial blood gas monitoring, the continued use of the apparatus was guided clinically by improvement in oxygen saturation, heart rate and respiratory rate and level of consciousness. The patient was at no stage obtunded to suggest carbon dioxide (CO_2) narcosis. On day ten of admission the apparatus was removed and oxygen saturation was maintained with a non-rebreather mask. After progressive reduction in supplemental oxygen requirements the patient was discharged fourteen days after admission to complete six months of TB treatment. At follow up six months after admission, the patient was well and had no complications.

The improvised bubble CPAP consisted of a mask from a bag valve mask, oxygen tubing connected to wall oxygen, a reservoir from a non-rebreather mask, and an underwater intercostal drain (ICD) set (Fig. 2). The construction was simple and required no special equipment. The intention of the apparatus was to provide 100% oxygen at adequate flow on inspiration through a tightly sealed facemask, while providing positive end expiratory pressure (PEEP) by forcing expiration through an underwater valve. The reservoir was removed from the non-rebreather and forced together with the tubing from the intercostal drain set into the 15 mm facemask inlet and any leaks were closed with adhesive tape. The distal end of the ICD tubing was placed 10 cm underwater to achieve approximately 10 cmH_20 PEEP. Oxygen run through a bubble humidifier was connected to the rebreather mask inlet and titrated to keep the self-inflated bag partially inflated during inspiration and the patient reported adequate flow to reduce dyspnea. The available oxygen flow meter was marked only to 15 l/min, but the patient's clinical requirement was above this, so the valve was opened above the maximum. The actual flow achieved is unknown. Leaks were tested for by occluding the mask, continuous bubbling indicated a well-sealed circuit. A mask with an inflatable cuff was used to prevent facial pressure sores. The mask was secured to the face using two bandages secured with slip knots with easy access for the patient or medical attendee to remove the mask quickly and easily if necessary. The patient and nursing staff were alerted to the danger of asphyxia with reduction or interruption of wall oxygen supply.

Discussion

This is effectively a Mapleson C type circuit which requires oxygen flow at twice minute volume to minimize rebreathing of CO_2, and may be considered an inefficient use of oxygen; however, there was no available equipment to construct a more efficient system (e.g. Mapleson A). Inaccurately set oxygen flow may result in wasteful use of oxygen if set too high or increased rebreathing and work of breathing if set too low. Although prolonged ventilation is potentially harmful because some rebreathing is inevitable with this circuit, it was successfully used for 8 days in this case.

Literature on the use of neonatal improvised bubble CPAP has shown it to be a safe and acceptable alternative to formal CPAP in resource limited settings. Adult patients with conditions needing emergency ventilator support in settings where limited resources prevent gold standard care can be assisted successfully using an improvised bubble CPAP. Cognisance of the risks involved should guide the use of this device for dire circumstances and ongoing effort should be made to obtain the best available care for patients.

Dissemination of results

The case was discussed at clinical meetings and instructions for assembly were made available to the various clinical teams.

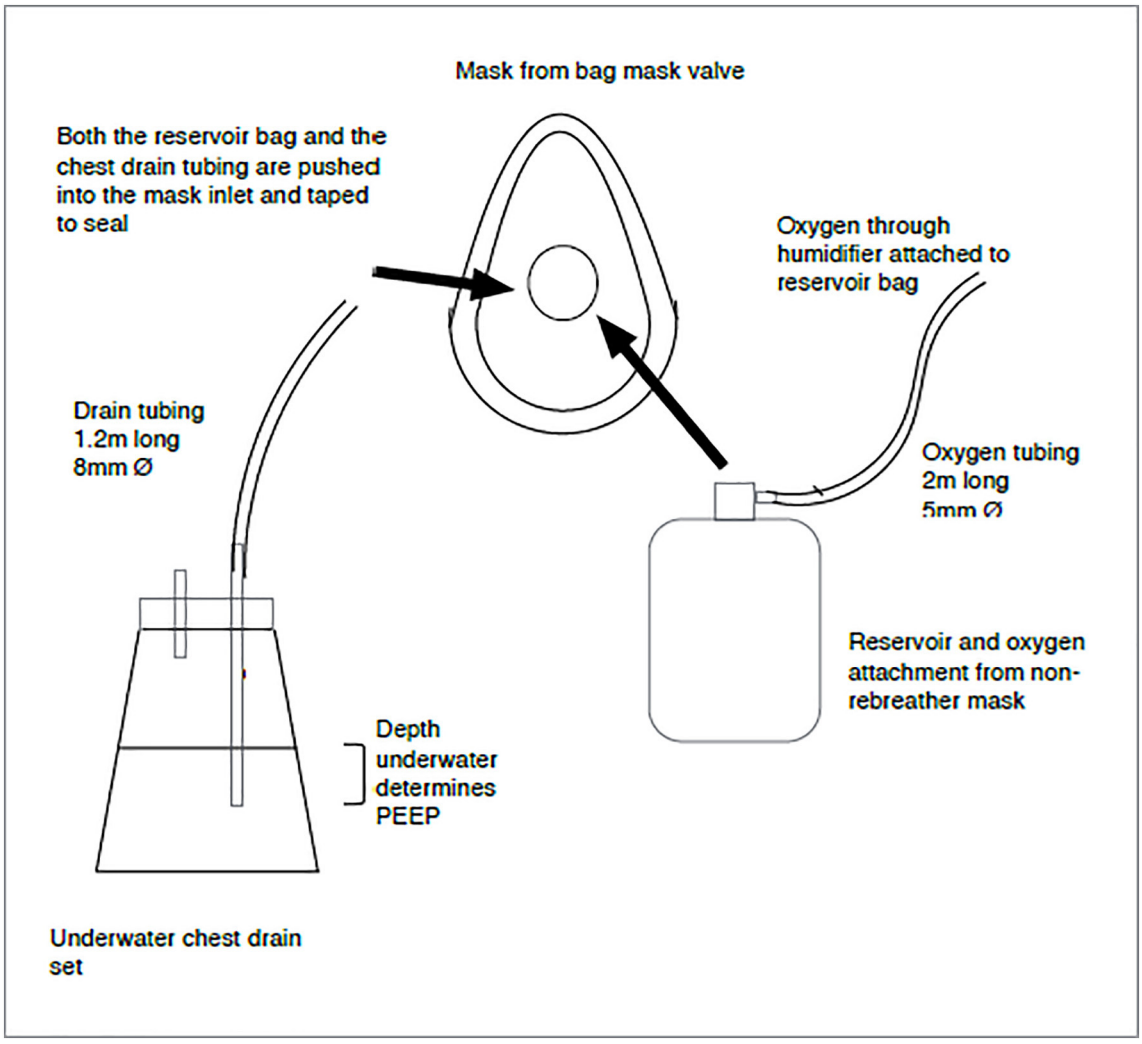

Fig. 2. Diagram of the improvised bubble CPAP device.

Author contribution

Authors contributed as follow to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: GM contributed 50%; TNM and HH contributed 25% respectively. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

Declaration of competing interest

The authors declared no conflicts of interest.

References

[1] Pooniya V. Management of neonatal respiratory distress syndrome by indigenous CPAP in a resource poor setting. J Pediatr Care 2015;1:1. https://doi.org/10.21767/2471-805X.100001.
[2] Jain H, Arya S, Mandloi R, Menon S. To study the effectiveness of indigenous bubble CPAP in management of respiratory distress in newborns. Int J Pediatr Res 2016;3(5):291–4. https://doi.org/10.17511/ijpr.2016.i05.04.
3. Milliner BH, Bentley S, DuCanto J. A pilot study of improvised CPAP (iCPAP) via face mask for the treatment of adult respiratory distress in low-resource settings. Int J Emerg Med 2019;12(7). https://doi.org/10.1186/s12245-019-0224-0.