8 Publications relating the use of CPAP in developing countries

1. An Evaluation of Bubble-CPAP in a Neonatal Unit in a Developing Country: Effective Respiratory Support That Can Be Applied By Nurses
   http://tropej.oxfordjournals.org/content/52/4/249.abstract
   Authors: Lanieta Koyamaibole, Joseph Kado, Josaia D. Qovu, Samantha Colquhoun and Trevor Duke

   Abstract
   To describe the implementation of bubble-CPAP in a referral hospital in a developing country and to investigate: the feasibility of nurses implementing bubble-CPAP and the impact of bubble-CPAP on need for mechanical ventilation and mortality. Retrospective evaluation of prospectively collected data from two time periods: 18 months before and 18 months after the introduction of bubble-CPAP. The introduction of bubble-CPAP was associated with a 50 per cent reduction in the need for mechanical ventilation; from 113 of 1106 (10.2 per cent) prior to bubble-CPAP to 70 of 1382 (5.1%) after introduction of CPAP (χ², p<0.001). In the 18 months prior to bubble-CPAP there were 79 deaths (case fatality of 7.1 per cent). In the 18 months after bubble-CPAP there were 74 deaths (CF 5.4 per cent), relative risk: 0.75 (0.55–1.02, χ², p=0.065). Nurses could safely apply bubble-CPAP after 1–2 months of on-the-job training. Equipment for Bubble-CPAP cost 15 per cent of the cost of the cheapest mechanical ventilator. The introduction of bubble-CPAP substantially reduced the need for mechanical ventilation, with no difference in mortality. In models of neonatal care for resource-limited countries, bubble-CPAP may be the first type of ventilatory support that is recommended. Its low cost and safety when administered by nurses makes it ideal for this purpose. Bubble-CPAP has the potential for being available at even lower cost than the current commercially available bubble systems used in this study.

2. Central nervous system infection is an important cause of death in underfives hospitalised with World Health Organization (WHO) defined severe and very severe pneumonia
   Authors: Socorro P. Lupisana, Petri Ruutub, P. Erma Abucejo-Ladesmac, Beatriz P. Quiambboa, Lorena Gozuma, Lydia T. Sombreroa, Vicente Romanod, Ian Rileye & Eric A.F. Simoes

   Abstract
   Over 6 years, 1667 children aged 2–59 months admitted for pneumonia [1287 severe and 380 very severe] were studied. The case fatality rate (CFR) in children with severe pneumonia was 2.1% and 14.3% with CNS infection, with very severe pneumonia the CFR was 18.9%, 10.4% in those with hypoxemia and 43.6% with CNS infection. High CFRs were associated with CNS infection and inability to drink/cyanosis. The appropriate management of children with very severe pneumonia should include cerebrospinal fluid examination, oxygen monitoring and possibly ventilated support, suggesting that these are minimal standards of care at the district hospital.

3. Hypoxaemia in children with severe pneumonia in Papua New Guinea
   Full free text: http://www.ingentaconnect.com/content/iuatld/ijtld/2001/00000005/00000006/art00004
   Authors: Duke T, Mgone J, Frank D.
   Source: Goroka Base Hospital, Eastern Highlands Province, Papua New Guinea.

   Abstract
   OBJECTIVES: To investigate the severity and duration of hypoxaemia in 703 children with severe or very severe pneumonia presenting to Goroka Hospital in the Papua New Guinea highlands; to study the predictive value of clinical signs for the severity of hypoxaemia, the predictive value of transcutaneous oxygen saturation (SpO2) and other variables for mortality.
DESIGN: Prospective evaluation of children with severe or very severe pneumonia. SpO2 was measured at the time of presentation and every day until hypoxaemia resolved. Children with a SpO2 less than 85% received supplemental oxygen. By comparing with a retrospective control group for whom oxygen administration was guided by clinical signs, we evaluated whether there was a survival advantage from using a protocol for the administration of oxygen based on pulse oximetry. We determined normal values for oxygen saturation in children living in the highlands.

RESULTS: In 151 well, normal highland children, the mean SpO2 was 95.7% (SD 2.7%). The median SpO2 among children with severe or very severe pneumonia was 70% (56-77); 376 (53.5%) had moderate hypoxaemia (SpO2 70-84%); 202 (28.7%) had severe hypoxaemia (SpO2 50-69%); and 125 (17.8%) had very severe hypoxaemia (SpO2 < 50%). Longer duration of cough or the presence of hepatomegaly or cyanosis predicted more severe degrees of hypoxaemia. After 10, 20 and 30 days from the beginning of treatment, respectively 102 (14.5%), 38 (5.4%) and 19 (2.7%) of children had persistent hypoxaemia; 46 children (6.5%) died. Predictors of death were low SpO2 on presentation, severe malnutrition, measles and history of cough for more than 7 days. The mortality risk ratio between the 703 children managed whose oxygen administration was guided by the use of pulse oximetry and the retrospective control group who received supplemental oxygen based on clinical signs was 0.65 (95%CI 0.41-1.02, two-sided Fisher’s exact test, P = 0.07).

CONCLUSION: There is a need to increase the availability of supplemental oxygen in smaller health facilities in developing countries, and to train health workers to recognise the clinical signs and risk factors for hypoxaemia. In moderate sized hospitals a protocol for the administration of oxygen based on pulse oximetry may improve survival.

4. Implementing an oxygen programme in hospitals in Papua New Guinea
DOI: http://dx.doi.org/10.1179/146532808X270716
Authors: Matai, Sens1; Peel, David2; Wandi, Francis3; Jonathan, Merilyn4; Subhi, Rami5; Duke, Trevor6

Abstract:
In Papua New Guinea (PNG), the most common cause of death among children under 5 years of age is pneumonia. Children with severe pneumonia need antibiotics and oxygen but oxygen shortages are common owing to the cost and complex logistics of transporting it in cylinders. Detection of hypoxaemia using clinical signs can be difficult, especially in highly pigmented children in whom cyanosis is difficult to recognise. Pulse oximetry is the most reliable, non-invasive way of detecting hypoxaemia. However, most hospitals in PNG do not have pulse oximetry. We proposed that the installation of a reliable, sufficient and cheap supply of oxygen and pulse oximeters might help to manage the disease; the installation, commissioning and testing processes. The ongoing training of clinical and engineering staff as well as two follow-up evaluations are described.

http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(08)61164-2/fulltext
Source: Centre for International Child Health, Department of Paediatrics, University of Melbourne, Murdoch Children’s Research Institute, Royal Children’s Hospital, Melbourne, Australia.

Abstract
BACKGROUND: In rural hospitals of developing countries, oxygen supplies are poor and detection of hypoxaemia is difficult. Oxygen concentrators and pulse oximeters might help to manage the disease;
however, use of such technology in developing countries needs comprehensive assessment. We studied the effect of an improved oxygen system on death rate in children with pneumonia in Papua New Guinea.

METHODS: We installed an improved oxygen system in five hospitals in Papua New Guinea, and assessed its use in more than 11 000 children with pneumonia (2001-07) and compared case-fatality rates. Admissions between January, 2001, and December, 2004, formed the pre-intervention group, and those between July, 2005, and October, 2007, formed the post-intervention group. Oxygen concentrators and pulse oximeters were introduced in the five hospitals, and a protocol for detection of hypoxaemia and clinical use of oxygen was supplied. All children admitted had their oxygen saturation measured; if it was less than 90%, oxygen was delivered via nasal prongs at a starting flow rate of 0.5-1 L/min. We recorded all costs associated with the establishment and maintenance of this system. The study was approved by the Medical Research Advisory Committee of Papua New Guinea, number MRAC 04.02.

FINDINGS: Before the use of this system, 356 of 7161 children admitted in the five hospitals for pneumonia died (case-fatality rate 4.97% [95% CI 4.5-5.5]), whereas 133 of 4130 children died in the 27 months after the introduction of the system (3.22% [2.7-3.8]). After the improved system was introduced, the risk of death for a child with pneumonia was 35% lower than was that before the project began (risk ratio 0.65 [0.52-0.78], p<0.0001). Mortality rates varied between hospitals. The estimated costs of this system were US$51 per patient treated, US$1673 per life saved, and US$50 per disability-adjusted life-year (DALY) averted.

INTERPRETATION: Pulse oximetry and oxygen concentrators can alleviate oxygen shortages, reduce mortality, and improve quality of care for children with pneumonia in developing countries. The cost-effectiveness of this system compared favourably with that of other public-health interventions.

6. Introduction of bubble CPAP in a teaching hospital in Malawi
Annals of Tropical Paediatrics: International Child Health, Volume 31, Number 1, February 2011, pp. 59-65(7)
DOI: http://dx.doi.org/10.1179/1465328110Y.0000000001
Authors: Van Den Heuvel, M; Blencowe, H; Mittermayer, K; Rylance, S; Couperus, A; Heikens, G T; Bandsma, R H J

Abstract:
BACKGROUND: Continuous positive airway pressure (CPAP) is relatively inexpensive and can be easily taught; it therefore has the potential to be the optimal respiratory support device for neonates in developing countries.

OBJECTIVE: The possibility of implementing bubble CPAP in a teaching hospital with a large neonatology unit but very limited resources was investigated.

METHODS: A CPAP system was developed consisting of a compressor, oxygen concentrator, water bottle to control the pressure and binaural prongs. Neonates with birthweights between 1 and 2.5 kg with persistent respiratory distress 4 hours after birth were eligible for bubble CPAP.

RESULTS: In the 7-week introduction period from 11 March until 27 April 2008, 11 neonates were treated with CPAP. Five of these neonates met the inclusion criteria and six neonates did not meet these criteria. Of the five neonates who received CPAP and met the inclusion criteria, three survived. The six infants who did not meet the inclusion criteria included three preterm infants with apnoea (all died), two with birthweights <1 kg (both died) and a firstborn twin (1.2 kg) who survived. No major complications of CPAP occurred. Bubble CPAP could be used independently by nurses after a short training period.

CONCLUSION: Successful long-term implementation of CPAP depends on the availability of sufficient trained nursing staff.

7. Neonatal pneumonia in developing countries
Abstract
Pneumonia contributes to between 750,000 and 1.2 million neonatal deaths and an unknown number of stillbirths each year worldwide. The aetiology depends on time of onset. Gram negative bacilli predominate in the first week of life, and Gram positive bacteria after that. *Streptococcus pneumoniae* probably causes about 25% of neonatal pneumonia. Interventions that would reduce mortality from this condition would have a large range of beneficial effects: improved maternal health, better management of other common neonatal conditions, and reduced long term childhood and adult morbidity.

8. **The effect of case management on childhood pneumonia mortality in developing countries**
   Authors: Evropi Theodoratou, Sarah Al-Jilaihawi, Felicity Woodward, Joy Ferguson, Arnoupe Jhass, Manuela Balliet, Ivana Kolcic, Salim Sadruddin, Trevor Duke, Igor Rudan and Harry Campbell

Abstract
BACKGROUND: With the aim of populating the Lives Saved Tool (LiST) with parameters of effectiveness of existing interventions, we conducted a systematic review of the literature assessing the effect of pneumonia case management on mortality from childhood pneumonia.

METHODS: This review covered the following interventions: community case management with antibiotic treatment, and hospital treatment with antibiotics, oxygen, zinc and vitamin A. Pneumonia mortality outcomes were sought where available but data were also recorded on secondary outcomes. We summarized results from randomized controlled trials (RCTs), cluster RCTs, quasi-experimental studies and observational studies across outcome measures using standard meta-analysis methods and used a set of standardized rules developed for the purpose of populating the LiST with required parameters, which dealt with the issues of comparability of the studies in a uniform way across a spectrum of childhood conditions.

RESULTS: We estimate that community case management of pneumonia could result in a 70% reduction in mortality from pneumonia in 0–5-year-old children. In contrast treatment of pneumonia episodes with zinc and vitamin A is ineffective in reducing pneumonia mortality. There is insufficient evidence to make a quantitative estimate of the effect of hospital case management on pneumonia mortality based on the published data.

CONCLUSIONS: The available evidence reinforces the effectiveness of community and hospital case management with World Health Organization-recommended antibiotics and the lack of effect of zinc and vitamin A supportive treatment for children with pneumonia. Evidence from one trial demonstrates the effectiveness of oxygen therapy but further research is required to give higher quality evidence so that an effect estimate can be incorporated into the LiST model. We identified no trials that separately evaluated the effectiveness of other supportive care interventions. The summary estimates of effect on pneumonia mortality will inform the LiST model.