CPAP for infants in rural and metropolitan special care nurseries: Perspectives of Nurse Unit Managers

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\section*{A R T I C L E   I N F O}

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Nursery
SCN
NICU
RDS
Education
Parent craft

\section*{A B S T R A C T}

\textbf{Background:} Use of Continuous Positive Airway Pressure (CPAP) in the management of Respiratory Distress Syndrome (RDS) and Transient Tachypnoea of the Newborn (TTN) for infants was introduced in Special Care Nurseries, Victoria, Australia approximately ten years ago. There has been scant evidence on outcomes on CPAP utilization in neonates cared for in developed countries. This study aimed to explore the associations between CPAP outcomes and nursery characteristics for infants with RDS and TTN.

\textbf{Method:} A retrospective cross-sectional study using a paper-based anonymous survey was utilized. Participants were Nurse Managers of Special Care Nurseries (SCN) in Victoria, Australia. Multiple correspondence analysis was applied to explore the structural relationships between the nursery background characteristics and the outcome variables. Ethical approval was provided by Peninsula Health.

\textbf{Results:} The response rate was 40% (N = 8); 10–100 + infants were treated in the SCN and not transferred and 0–16 required unplanned transfer. Positive CPAP outcomes were associated with preferable nursery characteristics such as higher bed capacity, more years’ experience using CPAP and shorter distances to a NICU. In contrast, unfavourable outcomes (increased work stressors on nurses and disagreement on general improvement within 6 h when referral was otherwise recommended) were related to a disadvantaged nursery environment.

\textbf{Conclusion:} Transfers have been reduced; outcomes have been positive for infants, parents and staff, yet education of nursing staff varied between nurseries.

\section*{1. Introduction}

Each year approximately 300,000 infants are born in Australia and approximately 22\% receive some form of resuscitation \cite{Birchs2014}. In 2013, 47\% of infants received oxygen and suction at delivery, 36\% received intermittent positive pressure ventilation (IPPV) and 1\% received external cardiac compressions (ECC) and artificial ventilation; clinical requirement for these interventions notwithstanding \cite{Hilder2014}. Further, 16\% were admitted to Special Care Nurseries (SCN) or higher-level care in Neonatal Intensive Care Units (NICU) for on-going specialised care \cite{Hilder2014}. The most common reason an infant is admitted to a SCN is for Respiratory Distress Syndrome (RDS) or Transient Tachypnoea of the Newborn (TTN) \cite{AIHW2015}. RDS is mostly a complication of prematurity \cite{AIHW2015}. The incidence of RDS is inversely proportional to gestational age; the more premature an infant, the more likely the infant will develop RDS \cite{Government2006}. The main reason for developing RDS is due to a surfactant deficiency which begins to synthesize more rapidly after 32 weeks gestation, and from 32 weeks gestation, alveolar structures also begin to proliferate and make respiration easier. (Government of Victoria) Respiratory distress is compounded most commonly by sepsis, meconium aspiration and delivery by caesarean section. (Government of Victoria) TTN is a form of respiratory distress affecting term and near-term infants that involves delayed clearance of foetal lung fluid \cite{Merenstein2006, Sinha2012}.

The majority of infants born late preterm (32–37 weeks gestation) are cared for in SCN’s and, until approximately 10 years ago, most were treated with oxygen therapy via a head box or incubator. If these infants required enhanced ventilation support, they were transferred to a NICU for ongoing treatment at greater human and financial cost to the family and the health service \cite{Buckmaster2012}. Continuous Positive Airway...
Pressure (CPAP) is a form of ventilatory support which became popular in the 1970's and has been the subject of extensive research in the subsequent decades, resulting in CPAP being a proven strategy to treat mild to moderate RDS/TTN in infants (Buckmaster, 2012). CPAP delivers positive pressure at the end of expiration of a spontaneously ventilating infant to maintain functional residual capacity (FRC). It decreases the work of breathing and oxygen requirements (Sinha et al., 2012).

CPAP has increased in use and has evolved to both a step-down treatment from mechanical ventilation and a stand-alone treatment and is often the first mode of ventilation support (Manley et al., 2012). CPAP has been shown to cause less damage to the airway; for example, there is less incidence of chronic lung disease and pulmonary haemorrhage (Martin et al., 2014; Waskosky and Huey, 2014). Over the last decade, some SCN's in Victoria have been using CPAP via a simple “bubble CPAP” system or a ventilator as a treatment option for infants with mild to moderate RDS/TTN, reducing the amount of transfers required to a higher-level NICU. Due to an increase in CPAP utilization in SCN's, the Department of Health Victoria, in conjunction with the Newborn Clinical Network and NETS (Newborn Emergency Transport Service, now PIPER) developed guidelines in 2014 for SCN staff to follow in order to provide consistencies in treatment (Newborn Care in Victoria, 2015; NCPAP). CPAP guidelines in general consisted of suggested parameters for treating infants with CPAP, including exemptions and contraindications for infants, as well as SCN’s minimum staffing requirements. (NCPAP).

A study by Buckmaster et al. (2007) in non-tertiary centres in New South Wales which included 300 infants on CPAP found that by having appropriately trained staff providing care to infants on CPAP resulted in significant benefits to infants and their families in SCN’s and reduced costs to the hospitals (Buckmaster et al., 2007). Five years later, Buckmaster (2012) conducted another investigation about which centres would be appropriate to deliver CPAP safely by reviewing a variety of maternity and neonatal service capability documents from Australia and New Zealand. These government documents outlined levels of neonatal care and concluded that distance/time to a tertiary centre, birth rate of the centre, and the ability of SCN staff to maintain the required skills and competencies in CPAP delivery as important factors. He suggested that the non-tertiary centre would need to deliver 1200–2000 infants per year in order to treat 50–100 infants with RDS/TTN, which would be an adequate number of admissions to maintain skills and competencies of nursing and medical staff (Buckmaster, 2012). Buckmaster further observed that staffing must also allow for at least one nurse/midwife experienced and trained in the use of CPAP available at all times when an infant was being treated with CPAP (Buckmaster, 2012). He also suggested that regional centres have higher requirements for skilled staff and other resources to stabilize and treat infants on CPAP than a metropolitan centre due to the cost and delays in transferring an infant to a tertiary centre (Buckmaster, 2012; Buckmaster et al., 2007).

There has been limited research undertaken in Victoria on this subject to date. The aim of the current study was to explore the association between CPAP outcomes and nursery characteristics for infants with RDS and TTN from the perspectives of SCN Nurse Unit Managers.

### Abbreviations

- CPAP: Continuous Positive Airway Pressure
- ECC: External Cardiac Compressions
- FRC: Functional Residual Capacity
- HFNC: High Flow Nasal Cannulae
- IPPV: Intermittent Positive Pressure Ventilation
- MCA: Multiple Correspondence Analysis
- NETS: Newborn Emergency Transport Service
- NICU: Neonatal Intensive Care Unit
- PIPER: Paediatric Infant Perinatal Emergency Retrieval
- RDS: Respiratory Distress Syndrome
- SCN: Special Care Nursery
- TTN: Transient Tachypnoea of the Newborn
- NSW: New South Wales

### Table 1

<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Level 1</strong> Low acuity nursery</td>
<td></td>
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<tr>
<td><strong>Level 2</strong> Mid-level Special Care Nursery (SCN)</td>
<td></td>
<td></td>
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<tr>
<td><strong>Level 3</strong> Tertiary level Neonatal Intensive Care Unit (NICU)</td>
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<tr>
<th>Location of response categories based on the two dimensions.</th>
<th>Dimension 1</th>
<th>Dimension 2</th>
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<tbody>
<tr>
<td><strong>Indicator</strong></td>
<td><strong>Label</strong></td>
<td><strong>Upper</strong></td>
</tr>
<tr>
<td>a Bed capacity</td>
<td>Less</td>
<td>More</td>
</tr>
<tr>
<td>b Year commenced CPAP</td>
<td>Less</td>
<td>More</td>
</tr>
<tr>
<td>c How many able to ventilate at one time</td>
<td>Less</td>
<td>More</td>
</tr>
<tr>
<td>d % EPT staff trained in bubble CPAP</td>
<td>Less</td>
<td>More</td>
</tr>
<tr>
<td>e Ratio of babies on CPAP to nurse</td>
<td>Less</td>
<td>More</td>
</tr>
<tr>
<td>f Distance (kms) from Level 2-Level 3 nursery</td>
<td>Less</td>
<td>More</td>
</tr>
<tr>
<td>g Positive impact on BF</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>h Supervised practice</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>i Opportunity to care for babies on CPAP</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>j Staff education</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>k NICU trained staff</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>l Improvement in hrs of referral</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>m NICU trained staff</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>n Positive impact on parent craft</td>
<td>Agree</td>
<td>Disagree</td>
</tr>
<tr>
<td>o Increased work stressors on nursing staff</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>p Extra support required from medical staff</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
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</table>
2.2. Instrument

The questionnaire (instrument) was designed by the researchers and included ten questions in part 1, requesting descriptive data about the unit size, capacity and activity, and a further ten questions in part 2 related to clinical guidelines, staff education, breastfeeding, and parent craft. The questions in part 2 used a 5-point Likert scale for response options ranging from strongly disagree to strongly agree. Content validity was determined after a review by SCN staff and a paediatrician.

The questionnaire and explanatory statement were distributed to the Nurse Unit Managers via post in an envelope to each mid-level SCN and included a post-free envelope for return to the researchers. Consent was implied by participation.

2.2.1. Ethics

Peninsula Health Low Risk Research Subcommittee of the Human Research Ethics Committee approved the study LRR14/PH 18.

2.2.2. Data analysis

Multiple correspondence analysis (MCA) (Greenacre, 1984) was applied to explore the structural relationships between nursery background characteristics and the outcome variables. MCA is an exploratory technique involving simultaneous consideration of multiple categorical variables and allows relationships among variables and their categories to be visualized by showing distances between the categories. Associated response categories are grouped together on a two-dimensional joint graphical display. In this study, continuous variables reflecting the nurseries’ background information were dichotomised to binary variables using its median as a cut-off point. The analysis was carried out via FactoMineR package (Lê et al., 2008) in R program.

3. Results

All respondents agreed to statements of communication with NETS, familiarity with government guidelines, increasing skills of SCN staff, increasing job satisfaction of nurses, and parents feeling well informed. These variables were excluded from the analysis due to non-variation. Five variables including 1) the number of infants transferred to a NICU, 2) SCN capacity to ventilate with CPAP at one time, 3) decisions-gestation, 4) decisions-weight, and 5) decisions-sepsis were also excluded from the analysis because of missing data.

Fig. 1 shows a two-dimension MCA map. The first and second dimensions accounted for 28.38% and 23.64% of the variance respectively (a cumulative total of 52.02%). Dimension 1 (X axis) separates high from low number of infants cared for per nurse, more from less number of cots in the nursery, low from high distance from Level 2 to Level 3 nursery, high from low percentage of staff trained in Bubble CPAP, improved from not improved in six hours of referral, with from without NICU trained staff, supervised from unsupervised practice, not increased from increased work stressors on nursing staff, more from less ventilation at one time, more from less years commenced CPAP. Dimension 2 (Y axis) separates staff education from no staff education, need from no need for extra support required from medical staff, no opportunity from opportunity to care for infants on CPAP. In Fig. 1, where indicators are grouped together, (See included Table for indicator labels) noticeably, positive aspects of neonatal outcomes, parentcraft, nursing satisfaction and their educational requirements are associated with preferable nursery characteristics such as higher cot capacity, more years of experience with bubble CPAP, and lower distances to a higher-level NICU. In contrast, unfavourable outcomes (e.g. increased work stressors on nurses and disagreement on general improvement within 6 h when referral was otherwise recommended) are related to a disadvantaged nursery environment (e.g., lower percentages of staff trained in bubble CPAP or a lower number of infants cared for per nurse).

4. Discussion

Utilization of continuous positive airway pressure (CPAP) as a treatment for infants in SCN's (now classified as Level 4 and 5 nurseries according to the Victorian Government Levels of neonatal care) has continued to increase over the last decade with more infants born and cared for in SCN's than those being transferred to tertiary centres (Newborn Care in Victoria, 2015; NCPAP). Nurse Unit Managers agree that skill levels and job satisfaction of staff nurses is improved with increased work challenges and increased requirements for clinical support. This group agrees that parent craft has been enhanced when infants requiring CPAP are cared for in SCN's at the hospital of birth. Staff nurse education is not standardised, nor does it conform to a certain level of education which is standard across SCN's in Victoria.
There may be a correlation between the number of SCN nursing staff trained in CPAP ventilation and the number of transfers to a higher-level NICU centre. Larger capacity SCN’s appear to have less transfers out which may be due to the higher availability of CPAP trained staff and exposure to a larger number of births, and subsequent SCN patient volumes. Additionally, CPAP, therefore, is a proven strategy to treat SCN infants requiring CPAP, and treatment guidelines should be suggested by the Victorian Government. Implementation of CPAP treatment guidelines requires increased skills and competencies of SCN nursing staff. Additionally, education and clinical training for SCN staff must be sufficient to improve the outcomes for infants requiring CPAP. Exposure to enough infants with RDS and TTN to consolidate learning, remain familiar with practices as explained in As Buckmaster (2012) described, an adequate volume of patients with RDS and TTN is necessary to afford SCN staff an adequate number of opportunities for learning and maintenance of competencies as well as to enhance staff satisfaction and reduce staff work stressors (Buckmaster, 2012). Hemani et al (2014) described educational training with clinical rotations to tertiary centres for SCN staff as an important factor to successfully treat infants requiring CPAP. This study, along with studies by Buckmaster (2012) confirm that CPAP is a simple, cost-effective treatment for SCN infants; but as Martin et al. (2014) state, the treatment should be used after training staff that are competent in the use of CPAP ventilation (Buckmaster, 2012; Martin et al., 2014; Manley et al., 2012). Successful treatment of infants requiring CPAP can result in better outcomes for neonates and their families in regards to decreased costs of travel to a distant higher-level NICU and disruption to the bonding/breastfeeding processes.

Long distances between SCN’s and higher-level NICU’s may necessitate a higher number of nursing hours per patient day in order to provide enough educational time for training and clinical rotations to reinforce clinical practices and staff confidence. Development of a standardised education curricula is needed to ensure that specialty competencies are obtained by SCN staff in order to provide consistency in clinical care.

Further research is warranted to evaluate infant, family, and staff outcomes after education, training, and competencies for SCN staff are standardised.

4.1. Limitations

This study did not include the years of experience utilizing CPAP, expertise of staff or limitations of medical staff, all of which could impact the successful treatment of infants with CPAP. Some SCN’s have been using CPAP longer than others, exposing them to higher volumes of infants requiring CPAP which may result in higher success rates. This was a small study with a 40% response rate of SCN’s taking place only in public hospitals in Victoria, as until recently, private hospitals in this state did not routinely treat infants requiring CPAP ventilation. Further studies taking place in private hospitals would enhance these results. The Department of Health, Victoria has published guidelines that are a guide only and subject to individual paediatrician’s preference for treatment. Some hospitals may determine that the guidelines must be strictly adhered to, while others may feel comfortable allowing clinicians to treat infants who fall outside the guidelines. Either practice has the potential to result in more infants requiring transfers from SCN’s to higher level NICU’s.

5. Conclusion

Bubble CPAP has been used as a successful treatment for SCN infant’s in Victoria Australia, which has been used increasingly over the last decade. Little research on education requirements for SCN nursing staff and volume of exposures to CPAP opportunities may have an impact on the care of the infant and family. Research is also lacking on how the standardisation of education and training may affect staff confidence and work stressors of staff, thereby improving the treatment of SCN infants requiring CPAP and limiting the transfers of infants to tertiary centres once CPAP has been initiated.

The study raises awareness of the ability for metropolitan and rural SCN’s in Victoria, Australia to successfully manage infants with RDS and/or TTN requiring CPAP. It also emphasizes the need for further research related to the needs of nursing staff for consistent education, clinical training and necessary competencies in order to care for infants requiring CPAP in special care nurseries.

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Conflicts of interest

The authors declare they have no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jnn.2018.09.002.

References


