BTS Guideline for diagnosing and monitoring paediatric sleep disordered breathing

Online Appendix 9 Question 9 Evidence Review and Protocol

Q9 For children receiving home mechanical ventilation, is pulse oximetry with carbon dioxide monitoring as good as multichannel study monitoring when monitoring mechanical ventilation at home?

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Question Evidence Review

Q9 For children receiving home mechanical ventilation, is pulse oximetry with carbon dioxide monitoring as good as multichannel study monitoring when monitoring mechanical ventilation at home?

Background

Children receiving home mechanical ventilation are a clinically varied group with a significant range of underlying problems such as neuromuscular diseases, bronchopulmonary dysplasia, cerebral palsy, congenital central hypoventilation syndrome and obstructive sleep apnoea. For those who have significant disability, bringing them to hospital for complex testing can be a major undertaking, so the ability to perform mechanical ventilation monitoring at home using pulse oximetry and carbon dioxide (CO_2) monitoring could be of significant benefit. This review will investigate if pulse oximetry with CO_2 monitoring is as good as multichannel study monitoring for monitoring children who are receiving home mechanical ventilation.

Outcomes

Adherence to treatment, sleep quality, quality of life, improved efficiency of care and the need for repeat monitoring.

Evidence Review

The initial literature search identified 12 studies, of which two were deemed relevant but no study directly compared pulse oximetry with CO_2 monitoring against multichannel study monitoring for monitoring mechanical ventilation at home.

Adherence to treatment, sleep quality, quality of life, improved efficiency of care and the need for repeat monitoring

There were no studies that reported on adherence to treatment, sleep quality, quality of life, improved efficiency of care or the need for repeat monitoring. Because of the lack of supporting evidence, the review has been extended to include the feasibility of pulse oximetry and CO_2 monitoring to detect respiratory events associated with non-invasive ventilation (NIV).

One study investigated whether pulse oximetry and transcutaneous CO_2 changes were associated with the occurrence of respiratory events during continuous positive airway pressure (CPAP) therapy. Defining abnormal gas exchange as an oxygen saturation (SpO_2) ≤90% for at least 2% of night time and/or a transcutaneous carbon dioxide ($PtcCO_2$) ≥50 mmHg for at least 2% of night time and/or an oxygen desaturation index ≥1.4/h, the sensitivity and specificity of abnormal gas exchange to detect abnormal polygraphy (defined as total respiratory events >1.5/h) were 0.64 and 0.47 respectively. However, no patients with moderate/severe polygraphy results (total respiratory events >5/h) had normal gas exchange.[1]

A second study reported on the polygraphic respiratory events of children on NIV. The polygraphies of 39 children with mixed diagnoses (13 with neuromuscular disease, 15 with obstructive sleep apnoea (OSA) and 11 with lung disease) were analysed. When the predominant respiratory event exceeded 50 events/h, NIV settings were adjusted and a second polygraphy was performed after 2–4 weeks. Unintentional leak and patient-ventilator asynchrony were the most common events. Unintentional leaks were most frequently associated with autonomic arousals, whereas patient ventilator asynchronies were rarely associated with autonomic arousal or >3% desaturation. For the eight children who had their ventilatory settings adjusted, the respiratory events significantly decreased on the repeat polygraphy ($p = 0.005$).[2]

Evidence Statements

Based on the very limited supporting evidence, pulse oximetry with CO_2 monitoring at home may be inferior to inpatient polygraphy for monitoring respiratory events during mechanical ventilation (**Ungraded**)

Recommendations

Based on the limited evidence, no recommendations can be made on the use of pulse oximetry with carbon dioxide monitoring for home monitoring of children receiving home mechanical ventilation

Good Practice Points

- ✓ If children are receiving continuous positive airway pressure therapy (CPAP) and bi-level positive airway pressure (BiPAP), regular monitoring should be provided with a minimum of pulse oximetry and carbon dioxide monitoring
- ✓ When deciding on which type of sleep study to perform, the relative risks and benefits of each should be discussed with the patient and/or carer
- ✓ Data download from a continuous positive airway pressure (CPAP) device or ventilator can help complement results from a sleep study, but operators should note that many ventilator algorithms, such as apnoea hypopnoea index (AHI), have not been validated in children

Research Recommendations

- Further research is needed into assessing the clinical outcomes of pulse oximetry and CO_2 monitoring against multichannel study monitoring for monitoring children receiving home mechanical ventilation
- Continuous positive airway pressure (CPAP) device and ventilator algorithms need to be validated in children

References

1. Amaddeo A, Caldarelli V, Fernandez-Bolanos M, et al. Polygraphic respiratory events during sleep in children treated with home continuous positive airway pressure: description and clinical consequences. *Sleep Medicine.* 2015;16:107-112.
2. Caldarelli V, Borel JC, Khirani S, et al. Polygraphic respiratory events during sleep with noninvasive ventilation in children: Description, prevalence, and clinical consequences. *Intensive Care Medicine.* 2013;39:739-746.

Question Protocol

Field	Content
Review Question	For children receiving home mechanical ventilation, is pulse oximetry with CO_2 monitoring as good as multichannel study monitoring when monitoring mechanical ventilation at home?
Type of review question	Intervention review
Objective of the review	Children receiving home mechanical ventilation are a clinically very varied group with a significant range of underlying problems. Many have very significant disability and bringing them to hospital for complex testing is a major undertaking. However, many will have a care package with trained professionals and therefore pulse oximetry/CO_2 monitoring may be feasible at home. Their clinical status may change over time and monitoring and adjustment of support is likely. • Is pulse oximetry/CO_2 monitoring testing feasible for such children? • Does pulse oximetry/CO_2 monitoring result in more changes in care? • Is there a difference in the identification of inappropriate ventilation settings when using pulse oximetry/CO_2 monitoring?
Eligibility criteria – population / disease / condition / issue / domain	Children (<17 years) receiving home mechanical ventilation
Eligibility criteria – intervention(s)	Pulse oximetry and CO_2 monitoring alone
Eligibility criteria – comparators(s)	Multichannel studies
Outcomes and prioritisation	Adherence to treatment Sleep quality Quality of life Improved efficiency of care Clinical outcomes Need for repeat monitoring
Eligibility criteria – study design	Randomised controlled trials Observational studies Case series Superiority studies

Other inclusion /exclusion criteria	Non-English language excluded unless full English translation Conference abstracts, Cochrane reviews, systematic reviews, reviews Cochrane reviews and systematic reviews can be referenced in the text, but **DO NOT** use in a meta-analysis
Proposed sensitivity / subgroup analysis, or meta-regression	Children <2 years with neuromuscular paralysis Children 2-16 years with neuromuscular paralysis Children <2 years with congenital central hypoventilation syndrome (CCHS) Children 2-16 years with CCHS Children <2 years with airway disorders Children 2-16 years with airway disorders
Selection process – duplicate screening / selection / analysis	Agreement should be reached between Guideline members who are working on the question. If no agreement can be reached, a decision should be made by the Guideline co-chairs. If there is still no decision, the matter should be brought to the Guideline group and a decision will be made by consensus
Data management (software)	RevMan5 — Pairwise meta-analyses Evidence review/considered judgement. Storing Guideline text, tables, figures, etc. Gradeprofiler — Quality of evidence assessment Gradepro — Recommendations
Information sources – databases and dates	MEDLINE, Embase, PubMED, Central Register of Controlled Trials and Cochrane Database of Systematic Reviews No date restriction
Methods for assessing bias at outcome / study level	RevMan5 intervention review template and NICE risk of bias checklist (follow instructions in '*BTS Guideline Process Handbook – Intervention Review'*)
Methods for quantitative analysis – combining studies and exploring (in)consistency	If 3 or more relevant studies: RevMan5 for meta-analysis, heterogeneity testing and forest plots (follow instructions in '*BTS Guideline Process Handbook – Intervention Review'*)
Meta-bias assessment – publication bias, selective reporting bias	GRADEprofiler — Intervention review quality of evidence assessment for each outcome (follow instructions in '*BTS Guideline Process Handbook – Intervention Review'*)

Rationale / context – what is known	There are thought to be varying practices and models of care across the UK. It is thought likely that the evidence base is small.