Feasibility and parental perception of home sleep studies during COVID-19: a tertiary sleep centre experience

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ABSTRACT

Objective Rapid implementation of home sleep studies during the first UK COVID-19 'lockdown'—completion rates, family feedback and factors that predict success.

Design We included all patients who had a sleep study conducted at home instead of as inpatient from 30 March 2020 to 30 June 2020. Studies with less than 4 hours of data for analysis were defined 'unsuccessful'.

Results 137 patients were included. 96 underwent home respiratory polygraphy (HRP), median age 5.5 years. 41 had oxycapnography (O_2/CO_2), median age 5 years. 56% HRP and 83% O_2/CO_2 were successful. A diagnosis of autism predicted a lower success rate (29%) as did age under 5 years.

Conclusion Switching studies rapidly from an inpatient to a home environment is possible, but there are several challenges that include a higher failure rate in younger children and those with neurodevelopmental disorders.

What is already known?

- Home sleep studies are feasible in children.
- Comorbidities such as neurodisability affect the quality of the study due to poor compliance.

What this study adds?

- When switching sleep studies that would have been conducted as inpatient prior to COVID-19 to home setting the failure rate raises significantly.
- Parental preference of home versus inpatient studies runs counter to study success.
- The real-time support of experienced sleep physiologist is considered crucial by parents in their confidence of conducting home studies.

BACKGROUND

Home respiratory polygraphy (HRP) can be a useful alternative to full polysomnography (PSG) for the diagnosis of sleep disordered breathing (SDB) in children.[1] Regular monitoring of overnight gas exchange is crucial in children on home mechanical ventilation (HMV), hence regular coupled oximetry and capnography (O_2/CO_2) is recommended.[2]

The Evelina London Paediatric Sleep service (ELCH-SS) offers a wide range of sleep investigations (from PSG to oximetry), supporting services within hospital and external secondary centres. Before COVID-19, one-third of ELCH-SS respiratory studies were already conducted at home on carefully selected children with the best chance of a successful study. These families would first attend the sleep service when equipment set-up was demonstrated. Children on HMV were studied as inpatients.

During the first COVID-19 lockdown period, ELCH-SS rapidly became fully ambulatory to ensure patient safety. This report describes the experience of a UK tertiary paediatric sleep service responding to the COVID-19 pandemic. The reasons behind successful and unsuccessful studies and families' perspectives are presented.

METHODS

Retrospective study assessing the outcome of home sleep studies conducted in children referred to the ELCH-SS during the first national lockdown for COVID-19 in UK. The study was approved as a clinical audit by Guy's and St Thomas' research and development department on 25 January 2021 (code 11731).

All children younger than 17 years of age undergoing a home sleep study between 30 March and 30 June 2020 were included. Patients requiring sleep studies for the diagnosis of SDB not requiring ventilatory support were allocated to HRP. Patients on HMV were allocated to home O_2/CO_2. The CO_2 probes were placed either on the forehead, chest or scapula. Recalibration was advised after 4 hours recording.

Patients whose parents did not verbally consent to take part in the audit were excluded. Repeat studies conducted in the study period due to failure of a home study were not included.

Studies were defined as successful when ≥4 hours of interpretable sleep data were available.[3]

A questionnaire for parents was designed for HRP and O_2/CO_2. It was organised in three sections (demographic, parents' feedback on instruction provided, parents' suggestions) plus one section only applicable for failed studies. Causes of failure were broken down into four categories: 'toleration

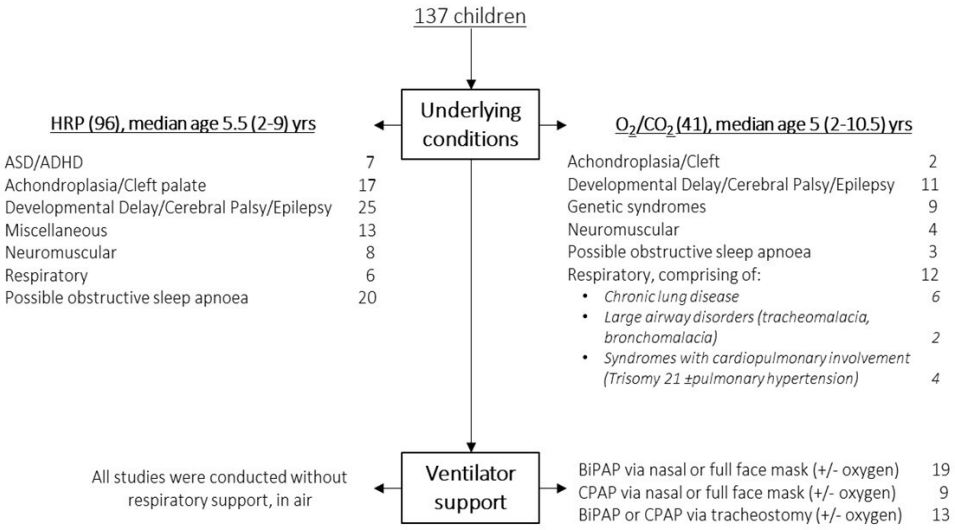

Figure 1 Patients' demographics. ADHD, attention deficit hyperactivity disorder; ASD, autism spectrum disorder; BiPAP, bilevel positive airway pressure; CP, cerebral palsy; CPAP, continuous positive airway pressure; HRP, home respiratory polygraphy; O_2/CO_2, oxycapnography; OSA, obstructive sleep apnoea; T21, trisomy 21 (Down syndrome).

issues' *(poor tolerance to sensors)*, 'missing signals' *(sensors dislodged resulting in loss of signal)*, 'limited data' *(child did not sleep)*, 'equipment fault' *(device failure)*. The questionnaires were administered by structured telephone interview within 3 months of any home study.

Statistical analysis

Data were analysed using Prism V.7.02 (GraphPad, La Jolla, California, USA). For all variables, a test of normality was performed. For non-parametric data, median (IQR) was reported.

RESULTS

Of the 194 home studies conducted over the study period (124 HRP, 70 O_2/CO_2), 137 families verbally consented to participate to the audit. Of those, 96 had HRP and 41 O_2/CO_2. Median age (IQR) at HRP and O_2/CO_2 was 5.5 (2–9) and 5 (2–10.5) years, respectively. Of patients on HMV undergoing O_2/CO_2, 28 were on non-invasive and 13 on invasive ventilation (figure 1).

Of the 137 studies evaluated, 88 (64%) were successful at first attempt.

Home respiratory polygraphy

Fifty-four (56%) of 96 HRP were successful. Of the 42 (44%) failed studies, 22 (54%) families had a previous sleep study pre-lockdown (either inpatient or home-based). Eighteen of 42 (43%) failed studies required repeated HRP and 10 (56%) were successful.

The most common cause of failure was missing signals (n=19, 45%) particularly from chest-abdominal bands. Children with autism spectrum disorder (ASD)/attention deficit hyperactivity disorder (ADHD) had the highest failure rate (71%, 5 of 7) due to toleration issues or missing signals. Children referred for obstructive sleep apnoea (OSA) had the highest success rate of 75% (15 of 20) (table 1). Irrespective of the underlying diagnosis, children under 5 years tolerated the equipment least well.

Oxycapnography

Thirty-four of 41 O_2/CO_2 (83%) were successful. Thirty-nine (95%) have had an inpatient study pre-lockdown. Of the 34 successful studies, 20 (59%) had an overnight carer present.

The most common cause of failure was the lack of capnography record in three of seven (43%) studies. Children with

Table 1 Outcome of home respiratory polygraphy grouped by underlying conditions

	ASD/ADHD	Achondroplasia/cleft palate	Developmental delay/cerebral palsy/epilepsy	Miscellaneous	Neuromuscular	Respiratory	Possible OSA
Patients (n), total N=96	7	17	25	13	8	6	20
Median age (IQR) (years)	7 (4–16)	2 (0.8–5.5)	6 (5–11.8)	2.5 (1–7.8)	10 (8–11.8)	8 (2–11.3)	5.5 (2–7.8)
Number of failure	5	10	10	6	4	2	5
% failure	71	59	40	46	50	33	25
Cause of failure, % (n)							
Issues with tolerance	40 (2)	0 (0)	40 (4)	50 (3)	25 (1)	0 (0)	60 (3)
Missing Signals	40 (2)	50 (5)	50 (5)	33 (2)	75 (3)	50 (1)	20 (1)
Limited data	20 (1)	10 (1)	10 (1)	0 (0)	0 (0)	0 (0)	20 (1)
Equipment fault	0 (0)	30 (3)	0 (0)	17 (1)	0 (0)	50 (1)	0 (0)
Other	0 (0)	10 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

ADHD, attention deficit hyperactivity disorder; ASD, autism spectrum disorder; OSA, obstructive sleep apnoea.

underlying genetic syndromes such as trisomy 21 had the highest failure rate (57%, four of seven).

Parents perception: results of questionnaire

If given the choice pre-COVID-19, 50 of 96 (63%) families who had HRP and 35 of 41 (85%) who had O_2/CO_2 would have preferred a home study. Parents of children with developmental delay/cerebral palsy/epilepsy had the greatest preference for a home study (74%, 14 of 19), while parents of children referred for OSA had the greatest preference (53%, 9 of 17) for an inpatient study.

Eighty-four (88%) who had HRP and 37 (90%) O_2/CO_2 felt the instructions provided were adequate but suggested issuing a 'frequently asked questions' list or a 'trouble shooting guide' with more graphics.

Ninety-one of 94 (97%) families who had HRP felt that remote signal monitoring would be beneficial. Families from both cohorts welcomed the possible introduction of video calls after they had received the equipment (101 of 135, 75%).

Thirty-four of 82 (41%) families, mostly of children with complex syndromes, felt 'concerned', 'apprehensive', 'stressed' about setting up the equipment at home. Eighty-five per cent (29 of 34) of families who had O_2/CO_2 felt confident due to equipment 'simplicity'.

DISCUSSION

The COVID-19 pandemic has led to the rapid reshaping of healthcare delivery across UK and internationally. Sleep services have been particularly affected as they rely on inpatient overnight admission.

The first lockdown in the UK was declared on 23 March 2020, and 1 week later, the ELCH-SS was converted to a full ambulatory diagnostic service. Between 30 March and 30 June 2020, 194 studies were conducted. Families no longer had the benefit of prior face-to-face instruction on how to use the equipment and children had to be allocated to the new home set-up irrespective of underlying diagnosis and age. Instructions were initially given via telephone call. This resulted in an overall failure rate of 44% for HRP in contrast to pre-pandemic where our failure rate for HRP was 10% and for inpatient study 7%–10% irrespective of diagnostic groups.

We see a range of children some with complex underlying neurodisability. As expected, the highest failure rate for HRP (71%) occurred in children with neurodisability (ASD/ADHD). Issues around sensory processing are well described in this cohort and careful preparation prior to diagnostic procedures is important and can increase success rates.[4] Home O_2/CO_2 studies were well tolerated in keeping with previous reports.[5] Eighty-five per cent of families in our study found home O_2/CO_2 simple and convenient. When asked, 74% families of children with developmental delay/cerebral palsy/epilepsy preferred having a home study, but up to 41% were anxious about setting up the study themselves.

A limitation of our study is its potential lack of generalisability to centres that might see a less complex group of children with fewer comorbidities—success rates were high in typically developing children with 'straightforward' OSA. Despite this limitation, we feel the information from this study can help inform more nuanced discussions with families when presenting pros and cons of home versus inpatient sleep studies.

In response to our findings, a number of changes have now been implemented. These include illustrations added to the instruction leaflet sent with the equipment, families given links to a YouTube sleep study instruction video made by our physiologists and adapted on the basis of the audit, and video clinics offered when the equipment arrives at their home. We are now able to monitor HRP traces remotely via a tablet device checked by our on-call night sleep physiologist who can also support families overnight. We will be evaluating the impact of these changes when we 'close the loop' of this audit.

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