National Institute for Health and Care Excellence

Draft

Obstructive sleep apnoea/ hypopnoea syndrome and obesity hypoventilation syndrome in over 16s

Evidence review D: Diagnostic tests for obstructive sleep apnoea/hypopnea syndrome, obesity hypoventilation syndrome and COPD-OSAHS overlap syndrome

NICE guideline

Diagnostic evidence review

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1 Diagnostic tests for obstructive sleep apnoea/hypopnea syndrome, obesity hypoventilation syndrome and COPD-OSAHS overlap syndrome

1.1. Review question: What are the most clinically and cost effective diagnostic strategies for obstructive sleep apnoea/hypopnea syndrome (OSAHS), obesity hypoventilation syndrome (OHS) and COPD-OSAHS overlap syndrome, including home- and hospital-based studies, and investigations such as oximetry, capnography, respiratory polygraphy and polysomnography?

1.2. Introduction

Accurate diagnosis of obstructive sleep apnoea/hypopnea syndrome (OSAHS), obesity hypoventilation syndrome (OHS) and COPD-OSAHS overlap syndrome is important. The diagnosis is usually made using physiological measures during sleep and when awake; these measures also give an indication of disease severity.

There are different diagnostic monitoring techniques, which vary based on the number and type of variables measured. The simplest diagnostic test is overnight oximetry, a two-channel sleep study recording oximetry and pulse rate. In some centres this is used as an initial screening test, in others it may be considered diagnostic along with a typical history of OSA. Limited respiratory polygraphy is a four or more channel sleep study, typically with oximetry, pulse rate, air flow and chest or abdomen effort band. This is probably the most widely used diagnostic test. Full polysomnography includes all aspects of respiratory polygraphy, along height and weight for OHS, and with electroencephalogram and electromyogram recording. The techniques can vary as to whether they are conducted in hospital or at home.

The same tests may be employed in the diagnosis of OHS and COPD-OSAHS overlap syndrome, although these conditions also require additional tests, including an assessment for respiratory failure, such as raised daytime carbon dioxide on arterial blood gas or raised venous bicarbonate. There are also diagnosis-specific tests for both OHS and COPD-OSAHS overlap syndrome (such as measurement of height and weight for OHS, and spirometry for COPD-OSAHS overlap syndrome) but these are widely agreed and not the subject of this evidence review.

In view of the variation in use of the available tests, this evidence review was performed to determine the most cost-effective diagnostic strategy for obstructive sleep apnoea/hypopnea syndrome (OSAHS), obesity hypoventilation syndrome (OHS) and COPD-OSAHS overlap syndrome.

1.3. PICO table

For full details see the review protocol in appendix A.

1 **Table 1: PICO characteristics of review question**

Population	People in whom OSAHS/OHS/COPD-OSAHS overlap syndrome is suspected based on symptoms or co-existing conditions.
Target condition	OSAHS/OHS/ COPD-OSAHS overlap syndrome
Index tests	Index test strategies include any one or more of the below: • home oximetry • home oxycapnography (OHS only) • home respiratory polygraphy • venous bicarbonate (OHS only) • hospital oxycapnography (OHS only) • hospital respiratory polygraphy
Reference standards	For diagnosis of OSAHS/ COPD-OSAHS overlap syndrome, reference standard is AHI/RDI/ODI >5 by hospital polysomnography for OSAHS For diagnosis of OHS, reference standard is hypercapnia on arterial/capillary blood gases for OHS **Test and treat** Any testing strategy compared with any other including the reference standards listed above

Statistical measures and Outcomes	**Accuracy outcomes**:
	
	• sensitivity
	• specificity
	• positive predictive values (PPV)
	• negative predictive values (NPV)
	
	Test and treat outcomes:
	
	Critical
	• mortality (dichotomous)
	• generic or disease specific quality of life (continuous)
	
	Important
	• sleepiness scores (continuous, e.g. Epworth)
	• apnoea-hypopnoea index or respiratory disturbance index (continuous)
	• oxygen desaturation index (continuous)
	• healthcare resource use (rates/dichotomous)
	• impact on co-existing conditions:
	  ○ HbA1c for diabetes (continuous)
	  ○ cardiovascular events for cardiovascular disease (dichotomous)
	  ○ systolic blood pressure for hypertension (continuous)

Study design	Single gate cross-sectional study designs will be included in the accuracy review. Two gate study designs will be excluded from the accuracy review

RCTs will be prioritised for test and treat comparisons; if insufficient RCTs are found, non-randomised studies will be considered if they adjust for key confounders (age, BMI, co-existing conditions).

1.4. Clinical evidence

1.4.1. Included studies

OSAHS

Twenty three studies were included in the review (22 diagnostic accuracy and one test and treat study) .[76, 90, 93, 100, 119, 140, 145, 149, 151, 162, 242, 286, 297, 298, 300, 369, 430, 443, 464, 475, 490, 590, 597] Evidence from these studies is summarised in the clinical evidence summary below (Table 2 - Table 6).

The data was analysed based on severity of OSAHS: all OSAHS to include studies with AHI ≥ 5 ; moderate-severe OSAHS (AHI ≥ 15) and severe OSAHS (AHI ≥ 30).

A few studies included in the review used proxy cut-off values for AHI, for example when the index threshold was not exactly what we were looking for, or not exactly the same as the reference standard stated in the protocol (AHI=5). In home oximetry for all OSAHS population, 2 studies used proxy values for the index test: Rofail 2010[475] – ODI ≥ 7 Wiltshire 2001[590] – ODI ≥10. In home respiratory polygraphy for mild OSAHS 1 study Golpe 2002[149] used proxy values for both the index test AHI ≥10 and the reference standard AHI ≥10. In home respiratory polygraphy for moderate OSAHS 1 study MASA 2013[297] used a proxy for the index test AHI ≥ 25. In hospital respiratory polygraphy 2 studies Calleja 2002[76] and Lloberes 1996[242] used proxy values for both index test AHI ≥10 and reference standard AHI ≥10 and 1 study Marrone 2011[286] used a proxy for the reference standard AHI ≥10. All studies that used proxy cut-off values were downgraded for indirectness.

There were two studies for home oximetry in all severities OSAHS, 3 studies for home oximetry in moderate-severe OSAHS, 8 studies for home respiratory polygraphy in all severities OSAHS,4 studies for home respiratory polygraphy in moderate-severe OSAHS, 4 studies for home respiratory polygraphy in severe OSAHS, 8 studies for in centre respiratory polygraphy in all severities OSAHS, 5 studies for in centre respiratory polygraphy in moderate-severe OSAHS, and 3 studies for in centre respiratory polygraphy in severe OSAHS. Some of the studies provided data for more than one analysis.

One test and treat study compared home respiratory polygraphy with polysomnography in moderate OSAHS.

OHS

No studies were identified that assessed diagnostic tests for OHS.

COPD-OSAHS overlap syndrome

One study assessed centre respiratory polygraphy in people with COPD-OSAHS overlap syndrome.[181] Evidence from the study is summarised in the clinical evidence summary below (Table 75).

The data was analysed based on severity of COPD-OSAHS overlap syndrome: all COPD-OSAHS overlap syndrome to include studies with AHI ≥ 5 ; moderate-severe COPD-OSAHS overlap syndrome (AHI ≥ 15) and severe COPD-OSAHS overlap syndrome (AHI ≥ 30).

Study reported results for in centre respiratory polygraphy in all severities COPD-OSAHS overlap syndrome, moderate-severe COPD-OSAHS overlap syndrome and severe COPD-OSAHS overlap syndrome.

See also the study selection flow chart in appendix C, sensitivity and specificity forest plots in appendix E, and study evidence tables in appendix D.

1.4.2. Excluded studies

See the excluded studies list in appendix H.

1.4.3. Summary of clinical studies included in the evidence review

Table 2: Summary of studies included in the evidence review (diagnostic accuracy) – home oximetry– OSAHS population

Study	Population	Target condition	Index test	Reference standard	Comments
Gyulay 1993[162] Australia Cross-sectional	N = 98 recruited and analysed People referred to specialist centre for suspected obstructive sleep apnoea Age: mean 49.96 (SD 2.5) Male/female ratio: 77:21 Ethnicity: not reported	Obstructive sleep apnoea	Pulse oximetry, desaturation index ≥ 15 (4%)	Laboratory polysomnography with a prespecified diagnostic AHI ≥ 15 (no % desaturation criteria)	Setting: laboratory/at home
Rofail 2010[475] Australia Cross-sectional	N=105 recruited, 98 completed the protocol with 92 analysed over three nights, 72 analysed over first night People with suspected obstructive sleep apnoea Age: mean 46.0 (SD 11.7) Male/Female ratio (%): 77/23 Ethnicity: 89.5% Caucasian	Obstructive sleep apnoea	Single-channel, nasal airflow device, RDI; single-channel oximeter (Flow Wizard), ODI	Laboratory polysomnography with a prespecified diagnostic AHI of ≥5	Setting: Laboratory and home

Study	Population	Target condition	Index test	Reference standard	Comments
Ryan 1995[490] UK Cross-sectional	N=69 analysed People with suspected sleep apnoea/ hypopnoea syndrome Age: mean 48 (SD 12) Male/Female ratio: 57/12 Ethnicity: not reported	Sleep apnoea/ hypopnoea syndrome	Oximetry device	Laboratory polysomnography with a prespecified diagnostic AHI of ≥15	Setting: Home and laboratory
Wiltshire 2001[590] UK Cross-sectional	N=84 analysed Patients were referred from ear, nose and throat surgeons, primary-care physicians and other chest physicians for assessment of suspected SAHS using full polysomnography Age: not reported Male/female: not reported Ethnicity: not reported	Obstructive sleep apnoea hypopnea syndrome	Home oximetry (Biox 3740, Ohmeda; UK)	Laboratory polysomnography - All underwent full polysomnography within 3 days of the home studies. Patients underwent full polysomnographic study which included EEG, EOG, EMG and ECG recordings, thoraco-abdominal and nasal-oral air flow measurements and pulse oximetry.	Setting: home

Table 3: Summary of studies included in the evidence review (diagnostic accuracy) – home respiratory polygraphy – OSAHS population

Study	Population	Target condition	Index test	Reference standard	Comments
de Oliveira 2009[100] Brazil Cross-sectional	N = 157 studied, 121 analysed for home and laboratory monitoring People referred to specialist centre for suspected OSAHS Age: mean 45 (SD 12) Male/female ratio (for PSG): 113/44 Ethnicity: not reported	Obstructive sleep apnoea syndrome	Portable respiratory monitor (respiratory polygraphy; Somnocheck), post-hoc AHI cut-off of 7	Laboratory polysomnography with a prespecified diagnostic AHI >5	Setting: sleep centre/at home
Garg 2014[140] USA Cross-sectional	N = 75 recruited and analysed People with high risk of OSA recruited from primary care and sleep clinics Age: mean 44.7 (SD 10.6) Male/female ratio: 18/57 Ethnicity: African American	Obstructive sleep apnoea	Portable sleep monitor (respiratory polygraphy; WatchPAT200), AHI	In-centre polysomnography PSG with no prespecified diagnostic AHI, RDI or ODI	Setting: sleep centre and home

Study	Population	Target condition	Index test	Reference standard	Comments
Gjevre 2011[145] Canada Cross-sectional	N = 47 recruited and analysed Women referred by sleep physicians for PSG assessment of possible OSA Age: mean 52 (SD 11) Male/female ratio: all female Ethnicity	Obstructive sleep apnoea	Portable sleep monitor (respiratory polygraphy; Embletta), AHI and ODI	In-laboratory polysomnography with a prespecified diagnostic AHI >5	Setting: laboratory and home
Golpe 2002[149] Spain Cross-sectional	N = 55 recruited, 37 analysed People referred to specialist centre for suspected sleep apnoea/hypopnoea syndrome Age: mean 52.7 (SD 13.3) Male/female ratio: 53:2	Sleep apnoea/hypopnoea syndrome	Portable sleep recording device (respiratory polygraphy; Apnoeascreen-I), RDI	In-laboratory polysomnography with a prespecified diagnostic AHI ≥10	Setting: laboratory and home
Masa 2013[297] Masa 2013[300] Masa 2011[298] Spain Cross-sectional	N=366 recruited 348 completed protocol People with suspected sleep apnoea/ hypopnoea syndrome Age: mean 48.7 (SD 11.8) Male/Female ratio: 263/85	Sleep apnoea/ hypopnoea syndrome	Home respiratory polygraphy (with Breas SC20), with AHI	In-hospital polysomnography with a prespecified diagnostic AHI of ≥15	Setting: Home or hospital

Study	Population	Target condition	Index test	Reference standard	Comments
	Ethnicity: not reported				
Pereira 2013[430] Canada Cross-sectional	N=128 analysed Age: mean: 50 (SD 12.3) Male/Female: 84/44 Ethnicity: not reported	Obstructive sleep apnoea	Home RP- patients were asked to wear the Level III portable monitoring device (MediByte; Braebon Medical Corporation, Ottawa, ON) for 2 consecutive nights at home.	Laboratory polysomnography - Recordings were conducted using Sandman Elite SD32+ digital sleep recording system (Natus [Embla]; Ottawa, ON), and included 4 EEG channels (C4-A1, C3-A2, O2-A1, F3-A2), 2 EOG channels (ROC-A1, LOC-A2), submental EMG, intercostal (diaphragmatic surface) EMG, bilateral anterior tibialis EMG, ECG, respiratory piezo bands (chest and abdomen), finger pulse oximetry, a vibration snore sensor, nasal pressure airflow, and oronasal thermocouple. PSG recordings were conducted as either a diagnostic study or, in the event of severe	Setting: home

Study	Population	Target condition	Index test	Reference standard	Comments
				OSA, a split-night study.	
Polese 2013[443] Brazil Cross-sectional	N=43 analysed Age: mean 70 (SD 5) Male/Female ratio(%): 44/56 Ethnicity: not stated	Obstructive sleep apnoea	The type 3 portable device used was the Stardust II® (Philips Respironics, Inc., Murrysville, PA, USA).	Laboratory polysomnography - Full-night PSG (Embla® S7000, Embla Systems, Inc., Broomfield, CO, USA) was performed by a trained technician. Prespecified clinical AHI cut-off	Setting: Laboratory and home
Xu 2017[597] China Cross-sectional	N=80 analysed People referred for evaluation of obstructive sleep apnoea Age: mean 47 (SD 14) Male/Female ratio (%): 76/24 Ethnicity: not reported	Obstructive sleep apnoea	Portable sleep monitor (respiratory polygraphy; Nox-T3), AHI	Laboratory polysomnography with no prespecified diagnostic AHI, RDI or ODI	Setting: Laboratory and home

Table 4: Summary of studies included in the evidence review (diagnostic accuracy) hospital repiratory polygraphy – OSAHS population

Study	Population	Target condition	Index test	Reference standard	Comments
Calleja 2002[76] Spain Cross-sectional	N= 86 recruited, 79 analysed People with clinically suspected sleep apnoea syndrome referred to sleep laboratory	Sleep apnoea/ hypopnoea syndrome	In centre respiratory polygraphy (MERLIN system), post hoc cut-off of 9.8 by manual scoring	Polysomnography with AHI >/= 10	Setting: sleep laboratory

Study	Population	Target condition	Index test	Reference standard	Comments
	Age: mean 52 (SD 11.1) Male/female ratio: 77/9 Ethnicity not reported				
Claman 2001[90] USA Cross-sectional	N = 42 recruited and analysed People referred for formal sleep study to evaluate suspected OSA Age: mean 54 (SD 12.9) Male/female ratio: 31:11 Ethnicity: not reported	Obstructive sleep apnoea	In centre respiratory polygraphy (BedBugg), AHI	Polysomnography with a prespecified diagnostic AHI >15	Setting: sleep laboratory
Emsellem 1990[119] USA Cross-sectional	N = 67 studied, 63 analysed People referred to specialist centre for suspected OSA Age: mean 45 (SD not reported) Male/female ratio: not reported Ethnicity: not reported	Obstructive sleep apnoea	Portable apnoea screening system (respiratory; polygraphy; EdenTrace), with a Portable Respiratory Index (PRI)	In-centre polysomnography with a specified diagnostic AHI >5	Setting: sleep centre

Study	Population	Target condition	Index test	Reference standard	Comments
Goodrich 2009[151] USA Cross-sectional	N = 50 recruited, 48 analysed People referred to specialist centre for suspected OSA Age: mean 44 (range 22 to 69) Male/female ratio: 35/13 Ethnicity: not reported	Obstructive sleep apnoea	Portable respiratory polygraphy using Lifeshirt, AHI ≥ 5	In-centre polysomnography with no prespecified diagnostic AHI	Setting: sleep centre
Lloberes 1996[242] Spain Cross-sectional	N=76 analysed People with suspected sleep apnoea/ hypopnoea syndrome Age: mean 51 (SD 11.5) Male/Female ratio: 54/22 Ethnicity: not reported	Sleep apnoea/ hypopnoea syndrome	Partially attended night-time respiratory recording (respiratory polygraphy), with AHI	Laboratory polysomnography with a prespecified diagnostic AHI of >10	Setting: Respiratory ward or sleep laboratory
Marrone 2001[286] Italy Cross-sectional	N=50 analysed People with suspected obstructive sleep apnoea syndrome Age: 49.6 ± 10.2 (units not reported) Male/Female ratio: 40/10	Obstructive sleep apnoea syndrome	Portable sleep monitor, AH/time in bed (respiratory polygraphy; POLYMESAM)	Laboratory polysomnography with a prespecified diagnostic AHI of ≥10	Setting: Laboratory

Study	Population	Target condition	Index test	Reference standard	Comments
	Ethnicity: not reported				
Ng 2010[369] China Cross-sectional	N=90 recruited, 80 analysed People with suspected obstructive sleep apnoea syndrome Age: mean 51.4 (SD 11.9) Male/Female ratio: 63/17 Ethnicity: not reported	Obstructive sleep apnoea syndrome	Portable, three-channel airflow monitor (Embletta PDS), AHI	Laboratory polysomnography with no prespecified diagnostic AHI, RDI or ODI	Setting: Laboratory
Polese 2013[443] Brazil Cross-sectional	N=43 analysed Age: mean 70 (SD 5) Male/Female ratio(%): 44/56 Ethnicity: not stated	Obstructive sleep apnoea	The type 3 portable device used was the Stardust II® (Philips Respironics, Inc., Murrysville, PA, USA).	Laboratory polysomnography - Full-night PSG (Embla® S7000, Embla Systems, Inc., Broomfield, CO, USA) was performed by a trained technician. Prespecified clinical AHI cut-off	Setting: Laboratory and home
Reichert 2003[464] USA Cross-sectional	N=51 recruited, 44 analysed in-laboratory and 45 analysed at home and in-laboratory People with suspected obstructive sleep apnoea Age: mean 52 (range 30-83)	Obstructive sleep apnoea	Portable, five-channel diagnostic system (respiratory polygraphy; NovaSom QSG)	Laboratory polysomnography with a prespecified clinical AHI cut-off ≥15	Setting: Laboratory and home

Study	Population	Target condition	Index test	Reference standard	Comments
	Male/Female ratio: 38/13 Ethnicity: not reported				
Xu 2017[597] China Cross-sectional	N=80 analysed People referred for evaluation of obstructive sleep apnoea Age: mean 47 (SD 14) Male/Female ratio (%): 76/24 Ethnicity: not reported	Obstructive sleep apnoea	Portable sleep monitor (respiratory polygraphy; Nox-T3)	Laboratory polysomnography with no prespecified diagnostic AHI, RDI or ODI	Setting: Laboratory and home

Table 5: Summary of studies included in the evidence review (diagnostic accuracy) – home respiratory polygraphy (Overlap syndrome)

Study	Population	Target condition	Index test	Reference standard	Comments
Jen 2020[36]	N= 36 recruited, 33 analysed Adult patients with known COPD and suspected OSA Age: mean 63 (SD 7) Male/female ratio: 63% male Ethnicity not reported	Overlap syndrome	In centre respiratory polygraphy (WatchPAT 200) AHI>/=5	Polysomnography with AHI >/= 5	Setting: sleep laboratory

Study	Population	Target condition	Index test	Reference standard	Comments

Table 6: Summary of studies included in the evidence review (test and treat) -OSAHS population

Study	Intervention and comparison	Population	Outcomes	Comments
Corral 2017[93] Spain RCT	**Home respiratory polygraphy** - HRP (Embla-Embletta; Natus, Pleasanton, CA) measurements included oxygen saturation, airflow through nasal pressure, and thoracic and abdominal movements measured by piezoelectric bands. The patients transported the device to their homes with a prior detailed explanation and functional test device provided by a technician in the hospital setting. When the patients returned the device the following day, the raw data files were transmitted to a computer and scored manually, excluding artefact periods. PSG was performed in patients with invalid HRP tests after several repetitions, and the subsequent cost was added to the HRP arm. For home RP, apnoea was the absence of flow lasting 10 seconds or more, and hypopnea was a discernible decrease in flow lasting 10 seconds or more with oxygen desaturation (>3%). N= 218 **Polysomnography** - For PSG, apnoea was the absence of flow lasting 10 seconds or more, and hypopnea was a discernible decrease in flow lasting 10 seconds or more with oxygen desaturation (>3%) or arousal. N=212	Age: median (IQR) – 50 (16) ESS: median (IQR) – 13 (5) Baseline AHI: median (IQR) Home RP: 20.9 (33.4) Polysomnography: 28.5 (43.3)	EQ5D ESS AHI ODI People given CPAP Change in 24-hour systolic blood pressure Cardiovascular event rate	Moderate severity OSAHS strata population (strata based on mean AHI) Test and treat study

Study	Intervention and comparison	Population	Outcomes	Comments
	The sleep physician recommended CPAP treatment in the case of a respiratory event index (REI) greater than or equal to 5 for HRP or an AHI greater than or equal to 5 for PSG with significant clinical symptoms (i.e., ESS .12), potentially secondary to OSA or previous cardiovascular diseases, and an REI or an AHI greater than or equal to 30, with clinical symptoms having less importance. Non-CPAP treatment included only correct sleep hygiene and a hypocaloric diet. **CPAP in both arms** - In patients (both arms) with a CPAP treatment indication, the optimal pressure for home use was obtained from a single recorded automatic-CPAP home session (S8-Autoset; Resmed, Sydney, Australia) by a researcher blinded to the study arm in the coordinating centre (centralized analysis). If, after three attempts, it was impossible to determine the optimal pressure, patients received polysomnographic titration, with the extra cost.			

See appendix D for full evidence tables.

1.4.4. Quality assessment of clinical studies included in the evidence review- diagnostic studies

Table 7: Clinical evidence summary –Home oximetry (diagnostic accuracy studies) – OSAHS population

Index Test (Threshold)	Number of studies	N	Sensitivity % (95% CI)	Quality	Specificity % (95% CI)	Quality
Tests						

Index Test (Threshold)	Number of studies	N	Sensitivity % (95% CI)	Quality	Specificity % (95% CI)	Quality
Home oximetry All OSAHS (AHI ≥ 5)	2	157	Pooled[5]: 51.81% (8.20 to 92.92%)	VERY LOW[1,2,3,4] due to risk of bias, serious inconsistency, serious indirectness and very serious imprecision	Pooled[5]: 95.83% (15.31 to 99.99%)	VERY LOW[1,2,3,4] due to risk of bias, serious inconsistency, serious indirectness and very serious imprecision
Home oximetry Moderate-severe OSAHS(AHI≥15)	3	251	Pooled[5]: 35.02% (12.98 to 65.24%)	VERY LOW[1,3,4] due to risk of bias, serious indirectness and serious imprecision	Pooled[5] 99.44% (95.35 to 99.98%)	LOW[1,3] due to risk of bias, serious indirectness

(1) Risk of bias was assessed using the QUADAS-2 checklist. The evidence was downgraded by 1 increment if the majority of studies were rated at high risk of bias and downgraded by 2 increments if the majority of studies were rated at very high risk of bias.
(2) Inconsistency was assessed by inspection of the sensitivity and specificity plots. The evidence was downgraded by 1 increment if the individual studies varied across 2 areas [(for example, 50–90% and 90–100%)] and by 2 increments if the individual studies varied across 3 areas [(for example, 0–50%, 50–90% and 90–100%)].
(3) Indirectness was assessed using the QUADAS-2 checklist items referring to applicability. The evidence was downgraded by 1 increment if the majority of studies were seriously indirect, and downgraded by 2 increments if the majority of studies are very seriously indirect
(4) Imprecision was assessed based on inspection of the confidence region in the diagnostic meta-analysis or, where diagnostic meta-analysis has not been conducted, assessed according to the range of confidence intervals in the individual studies. Two clinical decision thresholds were determined at the value above which a test would be recommended (90%), and a second below which a test would be considered of no clinical use (60%).The evidence was downgraded by 1 increment when the range of the confidence interval around the point estimate crossed one threshold, and downgraded by 2 increments when the range covered two
(5) Pooled sensitivity/specificity from diagnostic meta-analysis

Table 8: Clinical evidence summary –Home respiratory polygraphy (diagnostic accuracy study) – OSAHS population

Index Test (Threshold)	Number of studies	N	Sensitivity % (95% CI)	Quality	Specificity % (95% CI)	Quality
Tests						

Index Test (Threshold)	Number of studies	N	Sensitivity % (95% CI)	Quality	Specificity % (95% CI)	Quality
Home respiratory polygraphy All OSAHS (AHI ≥ 5)	8	872	Pooled[4]: 94.65% (89.81 to 97.36%)	VERY LOW[1,2,3] due to risk of bias, serious inconsistency, and serious imprecision	Pooled[4]: 57.69% (39.87 to 74.41%)	VERY LOW[1,2,3] due to risk of bias, serious inconsistency, and serious imprecision
Home respiratory polygraphy Moderate-severe OSAHS (AHI ≥ 15)	4	628	Pooled[4]:84.2% (59.67 to 95.87%)	VERY LOW[1,2,3] due to risk of bias, serious inconsistency and very serious imprecision	Pooled[4]: 88.95% (71.07 to 96.56%)	VERY LOW[1,2,3] due to risk of bias, serious inconsistency, and serious imprecision
Home respiratory polygraphy Severe OSAHS (AHI ≥ 30)	3	244	Pooled[4]: 64.25% (28.6 to 89.74%)	VERY LOW[1,2,3] due to risk of bias, serious inconsistency, and very serious imprecision	Pooled[4]: 92.06% (68.46 to 98.28%)	VERY LOW[1,2,3] due to risk of bias, serious inconsistency, and serious imprecision

(1) Risk of bias was assessed using the QUADAS-2 checklist. The evidence was downgraded by 1 increment if the majority of studies were rated at high risk of bias and downgraded by 2 increments if the majority of studies were rated at very high risk of bias.

(2) Inconsistency was assessed by inspection of the sensitivity and specificity plots. The evidence was downgraded by 1 increment if the individual studies varied across 2 areas [(for example, 50–90% and 90–100%)] and by 2 increments if the individual studies varied across 3 areas [(for example, 0–50%, 50–90% and 90–100%)].

(3) Imprecision was assessed based on inspection of the confidence region in the diagnostic meta-analysis or, where diagnostic meta-analysis has not been conducted, assessed according to the range of confidence intervals in the individual studies. Two clinical decision thresholds were determined at the value above which a test would be recommended (90%), and a second below which a test would be considered of no clinical use (60%).The evidence was downgraded by 1 increment when the range of the confidence interval around the point estimate crossed one threshold, and downgraded by 2 increments when the range covered two

(4) Pooled sensitivity/specificity from diagnostic meta-analysis

Table 9: Clinical evidence summary –Hospital respiratory polygraphy (diagnostic accuracy study) – OSAHS population

Index Test (Threshold)	Number of studies	N	Sensitivity % (95% CI)	Quality	Specificity % (95% CI)	Quality
Tests						
In centre respiratory polygraphy All OSAHS (AHI ≥ 5)	8	510	Pooled[4]: 94.58% (87.68 to 98.59%)	VERY LOW[1,2,3] due to risk of bias, serious inconsistency, and serious imprecision	Pooled[4]: 81.33% (57.92 to 92.48%)	VERY LOW[1,2,3] due to risk of bias, serious inconsistency and very serious imprecision
In centre respiratory polygraphy Moderate-severe OSAHS (AHI ≥ 15)	5	290	Pooled[4]: 93.29% (81.22 to 98.42%)	VERY LOW[1,2,3] due to risk of bias, serious inconsistency, and serious imprecision	Pooled[4]: 92.54% (82.71 to 97.48%)	VERY LOW[1,2,3] due to risk of bias, serious inconsistency and serious imprecision
In centre respiratory polygraphy Severe OSAHS (AHI ≥ 30)	3	162	Pooled[4]: 93.59% (71.09 to 99.15%)	VERY LOW[1,2,3] due to risk of bias, serious inconsistency, and serious imprecision	Pooled[4]: 95.51% (46.92 to 99.92%)	VERY LOW[1,2,3] due to risk of bias, serious inconsistency and very serious imprecision

(1) Risk of bias was assessed using the QUADAS-2 checklist. The evidence was downgraded by 1 increment if the majority of studies were rated at high risk of bias, and downgraded by 2 increments if the majority of studies were rated at very high risk of bias.

(2) Inconsistency was assessed by inspection of the sensitivity and specificity plots. The evidence was downgraded by 1 increment if the individual studies varied across 2 areas [(for example, 50–90% and 90–100%)] and by 2 increments if the individual studies varied across 3 areas [(for example, 0–50%, 50–90% and 90–100%)].

(3) Imprecision was assessed based on inspection of the confidence region in the diagnostic meta-analysis or, where diagnostic meta-analysis has not been conducted, assessed according to the range of confidence intervals in the individual studies. Two clinical decision thresholds were determined at the value above which a test would be recommended (90%), and a second below which a test would be considered of no clinical use (60%).The evidence was downgraded by 1 increment when the range of the confidence interval around the point estimate crossed one threshold, and downgraded by 2 increments when the range covered two

(4) Pooled sensitivity/specificity from diagnostic meta-analysis

Table 10: Clinical evidence summary –Hospital respiratory polygraphy (diagnostic accuracy study)- COPD-OSAHS overlap population

Index Test (Threshold)	Number of studies	N	Sensitivity % (95% CI)	Quality	Specificity % (95% CI)	Quality
Tests						
In centre respiratory polygraphy All COPD-OSAHS overlap syndrome (AHI ≥ 5)	1	33	96% (79 to100%)	LOW[1,2] due to risk of biasand serious imprecision	56% (21 to 86%)	LOW[1,2] due to risk of bias, , and serious imprecision
In centre respiratory polygraphy Moderate-severe COPD-OSAHS overlap syndrome (AHI ≥ 15)	1	33	77% (46 to 95%)	VERY LOW[1,2] due to risk of bias and very serious imprecision	90% (68% to 99%)	LOW[1,2] due to risk of bias, , and serious imprecision
In centre respiratory polygraphy Severe COPD-OSAHS overlap syndrome (AHI ≥ 30)	1	33	89% (52% to 100%)	VERY LOW[1,2] due to risk of biasand very serious imprecision	96% (79 to 100%)	LOW[1,2] due to risk of bias, , and serious imprecision

(1) Risk of bias was assessed using the QUADAS-2 checklist. The evidence was downgraded by 1 increment if the majority of studies were rated at high risk of bias, and downgraded by 2 increments if the majority of studies were rated at very high risk of bias.

(2) Imprecision was assessed based on inspection of the confidence region in the diagnostic meta-analysis or, where diagnostic meta-analysis has not been conducted, assessed according to the range of confidence intervals in the individual studies. Two clinical decision thresholds were determined at the value above which a test would be recommended (90%), and a second below which a test would be considered of no clinical use (60%).The evidence was downgraded by 1 increment when the range of the confidence interval around the point estimate crossed one threshold, and downgraded by 2 increments when the range covered two

Table 11: Clinical evidence summary: Home RP vs Hospital PSG (test and treat)– Moderate OSAHS

Outcomes	No of Participants (studies) Follow up	Quality of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with Hospital PSG	Risk difference with Home RP (95% CI)
Change in quality of life EQ5D, higher is better. Scale from: 0 to 1.	430 (1 study) 6 months	⨁⊖⊖⊖ VERY LOW1,2 due to risk of bias and imprecision		The mean change in EQ5D in the control groups was 0.03	The mean change in EQ5D in the intervention groups was 0.02 lower (0.05 lower to 0.01 higher)

Outcomes	No of Participants (studies) Follow up	Quality of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with Hospital PSG	Risk difference with Home RP (95% CI)
Change in quality of life FOSQ, higher is better Scale from: 5 to 20.	430 (1 study) 6 months	⨁⊖⊖⊖ VERY LOW1,2 due to risk of bias, imprecision		The mean change in FOSQ in the control groups was 6.5	The mean change in FOSQ in the intervention groups was 0.2 higher (3.09 lower to 3.49 higher)
Change in quality of life SF36 Physical, higher is better. Scale from: 0 to 100.	430 (1 study) 6 months	⨁⊖⊖⊖ VERY LOW1,2 due to risk of bias imprecision		The mean change in SF36 physical in the control groups was 2.6	The mean change in SF36 physical in the intervention groups was 1.4 lower (3.13 lower to 0.33 higher)
Change in quality of life SF36 mental, higher is better. Scale from: 0 to 100.	430 (1 study) 6 months	⨁⊖⊖⊖ VERY LOW1,2 due to risk of bias and imprecision		The mean change in SF36 mental in the control groups was 1.4	The mean change in SF36 mental in the intervention groups was 1.1 higher (1.16 lower to 3.36 higher)
Change in sleepiness score ESS, higher is worse. Scale from: 0 to 24.	430 (1 study) 6 months	⨁⨁⊖⊖ LOW1 due to risk of bias		The mean change in ESS in the control groups was -4.9	The mean change in ESS in the intervention groups was 0.7 higher (0.31 lower to 1.71 higher)
Mortality	No studies	N/A		Not available	Not available
AHI, higher is worse	430 (1 study) 6 months	⨁⨁⨁⊖ MODERATE1 due to risk of bias		The mean AHI in the control groups was 6.8	The mean AHI in the intervention groups was 1.4 higher (1.17 lower to 3.97 higher)
ODI, higher is worse	430 (1 study) 6 months	⨁⨁⨁⊖ MODERATE1 due to risk of bias		The mean ODI in the control groups was 4.5	The mean ODI in the intervention groups was 1.4 higher (0.72 lower to 3.52 higher)
People given CPAP, higher is worse	430 (1 study) 6 months	⨁⨁⊖⊖ LOW1,2 due to risk of bias andimprecision	RR 0.79 (0.68 to 0.92)	Moderate	
				679 per 1000	143 fewer per 1000 (from 54 fewer to 217 fewer)

Outcomes	No of Participants (studies) Follow up	Quality of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with Hospital PSG	Risk difference with Home RP (95% CI)
Change in 24hr systolic BP, higher is worse	430 (1 study) 6 months	⨁⨁⨁⊖ MODERATE1 due to risk of bias		The mean change in 24hr systolic BP in the control groups was 0.3	The mean change in 24hr systolic BP in the intervention groups was 0.1 higher (1.88 lower to 2.08 higher)
CV events Per 100 patients per year, higher is worse	430 (1 study) 6 months	⨁⨁⨁⊖ MODERATE1 due to risk of bias		The mean CV events in the control groups was 7.3	The mean CV events in the intervention groups was 0.9 lower (6.9 lower to 5.1 higher)

1 Risk of bias - downgraded by 1 increment if the majority of the evidence was at high risk of bias, and downgraded by 2 increments if the majority of the evidence was at very high risk of bias
2 Imprecision - downgraded by 1 increment if the confidence interval crossed one MID or by 2 increments if the confidence interval crossed both MIDs. MID for machine usage (adherence)- 1 hour; MID for Systolic and Diastolic BP – 5 mm hg; Established MIDs for SF-36 physical/mental- 2/3; FOSQ- 2 ; ESS -2.5; SAQLI – 2; EQ5D – 0.03. GRADE default MIDs (0.5XSD) used for all other continuous outcomes.

See appendix F for full GRADE tables.

1.5. Economic evidence

1.5.1. Included studies

One health economic study was identified with the relevant comparison and has been included in this review.[93] This study is summarised in the health economic evidence profile below (Table 12) and the health economic evidence table in appendix G.

1.5.2. Excluded studies

Four economic studies were excluded due to poor applicability or very serious limitations.[169, 183, 403, 530] Eight more papers were selectively excluded due to the availability of more applicable or better quality evidence.[24, 37, 175, 297, 298, 300, 301, 432] These are listed in appendix H, with reasons for exclusion given.

See also the health economic study selection flow chart in appendix F.

1.5.3. Summary of studies included in the economic evidence review

Table 12: Health economic evidence profile: Polysomnography versus Home Respiratory Polygraphy

Study	Applicability	Limitations	Other comments	Incremental cost	Incremental effects	Cost effectiveness	Uncertainty
Corral 2017[93]	Partially Applicable (a)	Minor Limitations (b)	Within trial (RCT) cost-utility analysis, with a 6month follow up.	£455 (c)	0.004 QALYs(d)	£113, 750 per QALY gained	Probability polysomnography cost effective (£20K/30K threshold): 0%/0%(c)

Abbreviations: QALY= quality-adjusted life years; RCT= randomised controlled trial

(a) As the study is from a Spanish perspective the study has been judged as partially applicable.

(b) While there are some limitations (see Table 13 and Table 14) due to the high incremental cost difference, clarification of these limitations would be highly unlikely to change the incremental cost-effectiveness ratio sufficiently for polysomnography to be considered cost effective.

(c) 2009 euros converted into UK pounds using purchasing power parities[404] Utilities were derived using EQ-5D, Euroqol 5 dimensions (scale: 0.0 [death] to 1.0 [full health]).

1.5.4. Unit costs

Table 13: UK costs of diagnostic tests

Study	Code	Cost per patient
Limited Home Study (outpatient) – considered applicable for a home respiratory polygraphy	DZ50Z	£189
Limited Sleep Study (inpatient) considered applicable for an in-hospital respiratory polygraphy	DZ50Z	£636

Source: National Schedule of NHS costs [107, 374]

Table 14: UK costs for Oximetry Test

Resource use [(a)(b)(c)]	Cost
Annuitized costs per use of oximetry device	£0.92
AAA batteries [(d)]	£0.09
Hospital based band 5 Nurse or band 6 physiologist (30 minutes) [(e)]	£19.00 - £23.50
Hospital based medical consultant (15 minutes) [(f)]	£27.25
Cost per oximetry test	**£47.27- £51.77**

Sources: NHS Supply Chain 2020[373], PSSRU 2019[97]

(a) Device costs can vary. In this example, the device cost for Nonin pulse oximetry wrist device (NPC code – FBC331) has been provided with an initial outlay of £561.38. This device costs have been sourced from the NHS supply chain[372, 373]. While other brands and types of oximetry devices were available, this was a brand that the committee were familiar with at a price point that seemed reasonable for the device.

(b) Device costs were annuitized to calculate annual equivalent costs of £120.13 for the Nonin device. The formula used to calculate annuitized annual costs is as follows:
E = K – [S / (1+r)n] / A(n,r)
Where E = equivalent annual cost; K = Purchase price of the oximetry device; S = resale value; r = discount (interest) rate; n = equipment lifespan; A(n,r) = annuity factor (n years at interest rate r). The following assumptions were used: resale value of £0, discount rate of 3.5% and equipment lifespan of 5 years as advised by the committee.

(c) Annuitized costs were divided by 130 to reflect that the device could be used 130 times per year. This assumption was based on committee advice where it was indicated that 48 hours would be required for the patient to do the home oximetry, return the device, and the data download to occur before the same device could be made available again. The device would be provided only Monday – Friday (therefore 5 uses every fortnight).

(d) An average cost for two AAA batteries (as would be required in the Nonin device) was calculated as £0.46 from the following NPC codes from the NHS supply chain[372] – WPA106, WPA146, WPA154 and WPA215. This was then divided by 5 as the batteries would need to be replaced after every fifth patient.

(e) The committee advised that a band 5 nurse or a band 6 physiologist could prepare the oximetry device and advise patients how to use the device overnight (15 minutes). The same band of staff would also carry out the data download and initial analysis (15 minutes). The relevant costs were sourced from the PSSRU. [96, 97]

(f) A consultant would look over the data and prepare the report (15 minutes). The relevant costs were sourced from the PSSRU. [96, 97]

The NICE guideline on preoperative testing (NG45)[361] reports the price of a blood gases test to be between £6.42 and £9.84 including laboratory and phlebotomy costs.

1.5.5. Health economic modelling

This analysis was conducted using a model covering the diagnostic and treatment pathway for symptomatic people suspected of having OSAHS (See 'Economic analysis report' for full details). Branches of this model were also used to find the most cost effective treatment for mild OSAHS (Evidence report E), the most cost effective variant of CPAP (Evidence report F) and the most cost effective oral device (Evidence report G).

1.5.5.1. Population and strategies evaluated

The modelled population were people with symptoms associated with OSAHS and the strategies compared were

- Home oximetry (Intervention for mild OSAHS)
- Home respiratory polygraphy (Intervention for mild OSAHS)
- Hospital respiratory polygraphy (Intervention for mild OSAHS)
- Home oximetry screening and then home respiratory polygraphy for those that tested negative (Intervention for mild OSAHS)
- Home oximetry (Conservative management for mild OSAHS)
- Home respiratory polygraphy (Conservative management for mild OSAHS)
- Hospital respiratory polygraphy (Conservative management for mild OSAHS)
- Home oximetry screening and then home respiratory polygraphy for those that tested negative (Conservative management for mild OSAHS)

  For all strategies, people diagnosed with moderate or severe OSAHS receive CPAP. In the 'Conservative management' strategies, people diagnosed with mild OSAHS receive only lifestyle advice. In the 'Intervention' strategies, 1/3 of people diagnosed with mild OSAHS receive CPAP, 1/3 receive custom-made mandibular advancement splints (MAS) and the remaining 1/3 receive only lifestyle advice.

1.5.5.2. Methods and data sources (Summary)

Diagnostic accuracy

Table 15: Pooled test accuracy (median of the posterior distribution)

Test threshold	Sensitivity (%)	Specificity (%)
Accuracy at detecting OSAHS (AHI>5 on polysomnography)		
Home Oximetry ODI>5	51.8	95.8
Home RP AHI >5	94.5	57.7
Hospital RP AHI > 5	95.0	81.3
Accuracy at detecting moderate/severe OSAHS (AHI>15 on polysomnography)		
Home Oximetry ODI>15	35.0	99.4
Home RP AHI >15	84.2	89.0
Hospital RP AHI > 15	93.2	92.5

See 1.4.4 for details.

- Table 15 shows the sensitivities and specificities used in the model. These are the estimates from the guideline review pooled using diagnostic meta-analysis. Where a second test was performed the accuracy of the second test was assumed to be independent of the results of the first test inm the base case. In sensitivity analyses, we explored different levels of positive correlation between test results.
- For those people with moderate or severe OSAHS who were misdiagnosed as having no OSAHS after the first test, it was assumed that they would have a second test. This is because they are likely to be markedly symptomatic, which would entail further investigation.

Treatment effects

- CPAP and MAS were assumed to have an immediate impact on quality of life (measured in terms of EQ-5D). These were estimated from randomised trials comparing each intervention with conservative management.
- CPAP was estimated to have an impact on ESS and quality of life (measured in terms of EQ-5D). ESS was estimated from randomised trials comparing CPAP with conservative management and subgrouped by severity. The ESS improvements were mapped to EQ-5D using a published mapping equation. The resulting EQ-5D improvements used in the base case analysis and were applied to the whole treatment period:

	CPAP vs conservative management	
	ESS	**EQ-5D**
Mild OSAHS	-2.870	0.028
Moderate OSAHS	-2.04	0.020
Severe OSAHS	-3.41	0.033

- For the base case, the improvement in EQ-5D was 0.023 for custom-made MAS. These were from the TOMADO trial in mild and moderate OSAHS. There was assumed to be no benefit for patients with severe OSAHS.
- Compared with conservative management, CPAP was assumed to have the same impact on the incidence of road traffic accidents, regardless of severity. A proportion of the accidents are fatal and these are associated with reduced length of life. Non-fatal accidents are associated with reduced quality of life.
- For treated patients the risk of an RTA was assumed to be the same as the general population. The treatment effect was OR=0.169, which was derived from NICE technology appraisal for CPAP in OSAHS (TA139)[362]
- Cardiovascular events were included in the model,
  - For moderate and severe OSAHS there was a modest reduction derived using QRISK from a 1.0mmHg reduction in systolic blood pressure
  - for the mild OSAHS population we assumed that CPAP had no impact
- The rate at which people drop out from using CPAP was differentiated by time and by OSAHS severity. It was assumed that when patients dropped out, their quality of life, RTA risk and CV risk returned to their baseline levels.
- The baseline probability of both cardiovascular events and RTAs were for men aged 50 at the commencement of treatment. The former was estimated using QRISK and the latter were from Department of Transport statistics.

CPAP costs

- The cost of fixed-pressure CPAP devices and consumables were extracted from the NHS Supply Chain catalogue. The unweighted mean of different devices was used in the model base case - £248. The device costs were annuitized using a discount rate of 3.5% and assuming the equipment is replaced after 7 years.
- In addition to the device the following costs were included:
  - Telemonitoring costs for the first year ResMed (£45).
  - Consumables (£121per year)
  - Education and set up was costed as a respiratory consultant-led outpatient consultation (NHS Reference cost £146)
  - 3 month and then annual follow-up was a non-consultant-led outpatient consultation. (NHS Reference cost £120)
  - It was assumed that 18% of patients using fixed-CPAP would require re-titration (£16)

MAS costs

- The unweighted average cost of custom-made mandibular advancement splints was £350. The durability of these devices in the base case was assumed to be 2 years.
- Education and set up, and 3 month and annual follow-up were done by a dentist (NHS Reference cost £113).

Other costs and effects

- The cost of treating RTAs was taken from Department of Transport data.
- The cost of treatment, standardised mortality ratios and utility (quality of life) lost associated with cardiovascular events were taken from various sources.

Computations

The key outcomes were mean NHS cost per patient and mean QALYs per patient. These were calculated using a state-transition (Markov) model structure. Costs and QALYs occurring in the future were discounted at 3.5% per year to be consistent with the NICE reference case. The results were calculated both:

- Deterministically, based on the point estimates of each input parameter
- Probabilistically, based on a distribution for each input parameter (estimated using its standard error) and sampling the results 10,000 times before calculating a mean (Monte Carlo simulation.

1.5.5.3. Results

The base case results can be found in Table 16, Table 17 and Figure 1. The lowest cost strategy was Home oximetry with conservative management for mild OSAHS and the most costly was Hospital RP with Intervention for mild OSAHS. The difference between strategies in terms of the cost of treating cardiovascular events was negligible. This was partly because of the modest treatment effect assumed but also because the savings in patients treated with CPAP were offset by increased costs in those who were now surviving fatal road traffic accidents. The strategy with the greatest QALYs gained was Hospital RP with intervention. At a threshold of £20,000 per QALY, Home RP with intervention for mild OSAHS was the most cost effective strategy.

Table 16: Breakdown of mean cost (£) by diagnostic strategy in order of total cost (deterministic)

	Diagnosis	Treatment	Road traffic accidents	Cardiovascular events	Total
Oximetry (ConsM)	80	1,510	423	4,924	6,937
Screening (ConsM)	135	1,592	416	4,924	7,067
Home RP (ConsM)	190	2,139	350	4,922	7,601
Hospital RP (ConsM)	637	2,303	330	4,921	8,190
Oximetry (Intervention)	80	2,434	315	4,925	7,753
Home RP (Intervention)	190	2,943	257	4,924	8,314
Screening (Intervention)	135	2,762	281	4,926	8,103
Hospital RP (Intervention)	637	2,980	250	4,923	8,790

Table 17: Base case cost effectiveness of strategies in order of mean cost (probabilistic)

N		Mean costs	Mean QALYs	Cost per QALY gained (versus n=1)	INMB* (n versus n=1)	INMB* Rank	Probability highest INMB*	Median Rank of INMB*	95% CI of INMB rank*	
									Lower	Higher
1	**Oximetry (ConsM)**	6,943	13.526		0	7	8%	7	1	8
2	**Screening (ConsM)**	7,074	13.531	24,173	-23	8	0%	7	2	8
3	**Home RP (ConsM)**	7,601	13.587	10,685	573	5	2%	4	2	8
4	**Oximetry (Intervention)**	7,756	13.595	11,693	577	4	1%	4	2	6
5	**Screening (Intervention)**	8,107	13.622	12,010	774	3	6%	3	1	6
6	**Hospital RP (ConsM)**	8,194	13.606	15,612	351	6	0%	6	3	8
7	**Home RP (Intervention)**	8,316	13.654	10,722	1,188	1	71%	1	1	6
8	**Hospital RP (Intervention)**	8,793	13.664	13,312	929	2	12%	3	1	8

ConsM=Conservative management, CPAP=continuous passive airway pressure, INMB=Incremental net monetary benefit, QALY=quality-adjusted life-year, RP=respiratory polygraphy
** at £20,000 per QALY gained*

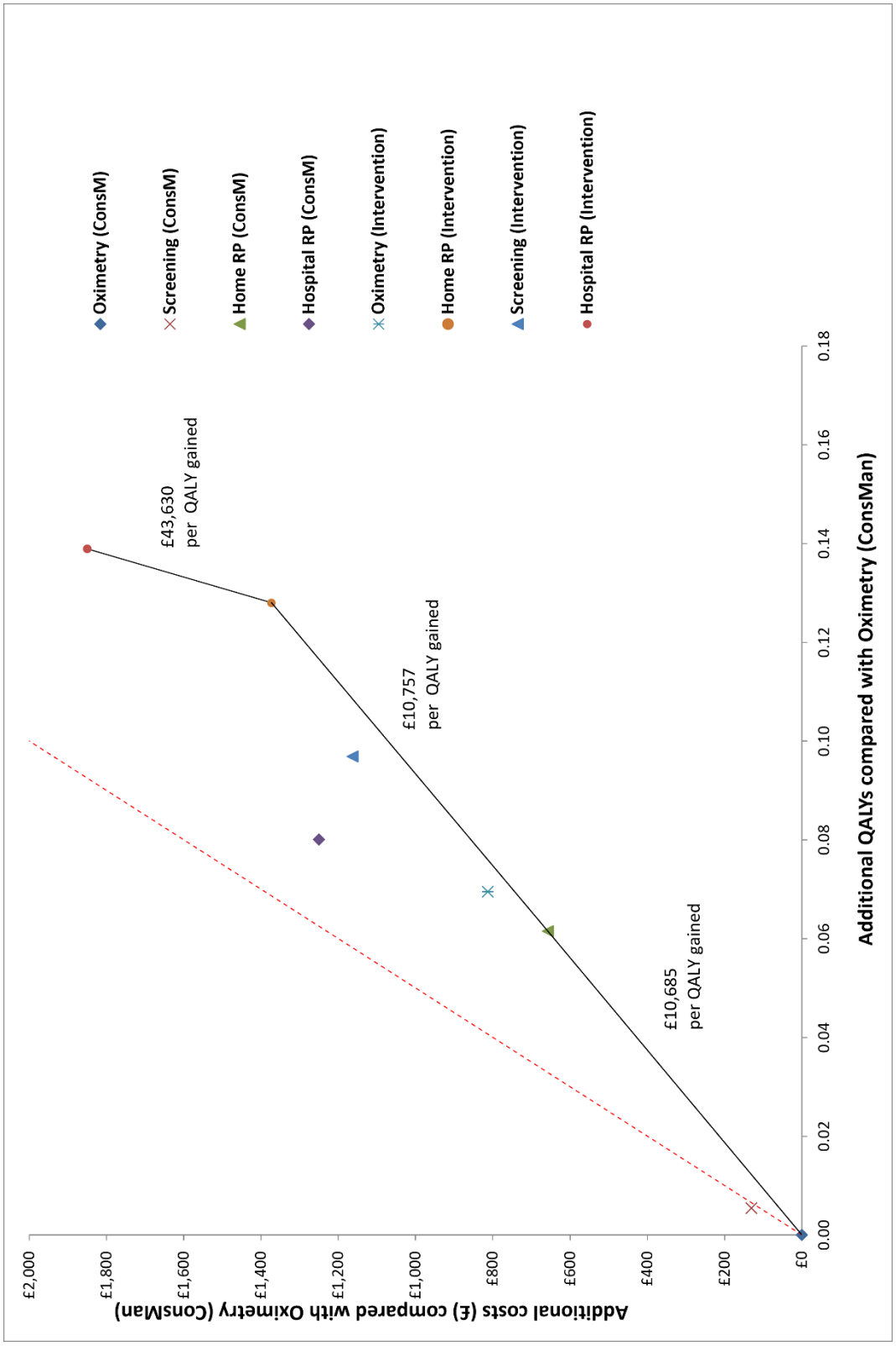

Figure 1: Base case cost effectiveness results (probabilistic)

A number of sensitivity analyses were conducted (Table 18 and Table 19). The ranking of treatments was quite stable across the analyses. In every scenario one of the four 'intervention' strategies was ranked first. Only in two scenarios was home respiratory polygraphy not ranked first:

- When it was assumed that all people with mild OSAHS receive CPAP then home oximetry screening was most cost effective test. We conducted a threshold analysis on the proportion of people that receive CPAP for mild OSAHS to see at which point the most cost effective strategy switches. If less than 92% of them receive CPAP, then Home respiratory polygraphy is the most cost-effective test. The reason that it switches is that if we are treating people with mild OSAHS exactly the same as people with moderate OSAHS then the need to differentiate mild OSAHS from moderate OSAHS is not important, whereas far more patients with moderate OSAHS are misdiagnosed as having Mild OSAHS with home oximetry than with home respiratory polygraphy.
- When we relaxed the assumption that that people with moderate/severe OSAHS would be retested due to persistence of symptoms then oximetry screening was the most cost effective strategy. We conducted a threshold analysis on the proportion of these misdiagnosed people that are retested to see at which point the most cost effective strategy switches. If 68% or more are re-tested, then Home respiratory polygraphy is the most cost-effective test. If it is less than that, then the screening strategy, where *all* patients testing negative are *systematically* retested yields more QALYs and is more cost effective.

Table 18: Diagnostic strategy ranking - Sensitivity analyses (probabilistic)

	Rank of net monetary benefit at £20,000 per QALY gained							
Analysis	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Base case results	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Oximetry (Interv'n)	Home RP (ConsM)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
Diagnostic accuracy of strategies								
Misdiagnosis threshold for no OSA and moderate/severe OSA	Home RP (Interv'n)	Screening (Interv'n)	Oximetry (Interv'n)	Hospital RP (Interv'n)	Home RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)	Hospital RP (ConsM)
Retest turned off in model (all diagnostic strategies except screening)	Screening (Interv'n)	Screening (ConsM)	Home RP (Interv'n)	Hospital RP (Interv'n)	Home RP (ConsM)	Hospital RP (ConsM)	Oximetry (Interv'n)	Oximetry (ConsM)
Retest correlation of 20%	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Oximetry (Interv'n)	Hospital RP (ConsM)	Screening (ConsM)	Oximetry (ConsM)
Retest correlation of 40%	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Hospital RP (ConsM)	Oximetry (Interv'n)	Screening (ConsM)	Oximetry (ConsM)
Home oximetry diagnostic meta-analysis includes Pataka 2016	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Oximetry (Interv'n)	Home RP (ConsM)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
Diagnostic strategies								

Analysis	Rank of net monetary benefit at £20,000 per QALY gained							
	1	2	3	4	5	6	7	8
Retest strategy for oximetry and home RP is Hospital RP	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Oximetry (Interv'n)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
1st test in screening strategy home RP	Home RP (Interv'n)	Screening (Interv'n)	Hospital RP (Interv'n)	Home RP (ConsM)	Oximetry (Interv'n)	Screening (ConsM)	Hospital RP (ConsM)	Oximetry (ConsM)
2nd test in screening strategy hospital RP	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Oximetry (Interv'n)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
1st test in screening strategy home RP, second test hospital RP	Home RP (Interv'n)	Screening (Interv'n)	Hospital RP (Interv'n)	Oximetry (Interv'n)	Home RP (ConsM)	Screening (ConsM)	Hospital RP (ConsM)	Oximetry (ConsM)
Polysomnography after second test for all False Negatives with underlying moderate/severe disease	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Oximetry (Interv'n)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
Polysomnography after first test for all False Negatives with underlying moderate/severe disease	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Oximetry (Interv'n)	Home RP (ConsM)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
Treatment more cost effective								
CPAP ESS effect is based on ESS subgroup (not AHI subgroup)	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Hospital RP (ConsM)	Oximetry (Interv'n)	Oximetry (ConsM)	Screening (ConsM)
Reduce CPAP dropout rate 20%	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Oximetry (Interv'n)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
NHS and police costs	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Oximetry (Interv'n)	Home RP (ConsM)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
CPAP device lower cost	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Oximetry (Interv'n)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
CPAP device and staff costs for education and setup are lower	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Oximetry (Interv'n)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
All of the above (treatment more cost effective)	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Hospital RP (ConsM)	Oximetry (Interv'n)	Oximetry (ConsM)	Screening (ConsM)
Treatment less cost effective								

Analysis	Rank of net monetary benefit at £20,000 per QALY gained							
	1	2	3	4	5	6	7	8
Increase CPAP drop out rate 20%	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Oximetry (Interv'n)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
High CPAP cost: auto-CPAP with telemonitoring	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Oximetry (Interv'n)	Home RP (ConsM)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
CPAP lifetime 5 years	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Oximetry (Interv'n)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
Turn off RTA treatment effects	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Oximetry (Interv'n)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
Turn off CV treatment effects	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Oximetry (Interv'n)	Home RP (ConsM)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
Turn off CV and RTA treatment effects	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Oximetry (Interv'n)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
All of the above (treatment less cost effective)	Home RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Oximetry (Interv'n)	Hospital RP (Interv'n)	Oximetry (ConsM)	Screening (ConsM)	Hospital RP (ConsM)
Cohort								
Low starting age of 30 years	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Oximetry (Interv'n)	Home RP (ConsM)	Hospital RP (ConsM)	Screening (ConsM)	Oximetry (ConsM)
High starting age of 80 years	Home RP (Interv'n)	Oximetry (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)	Hospital RP (Interv'n)	Hospital RP (ConsM)
Higher risk profile	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Oximetry (Interv'n)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
Lower risk profile	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Oximetry (Interv'n)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
Prevalence estimate of OSAHS is lower	Home RP (Interv'n)	Oximetry (Interv'n)	Screening (Interv'n)	Hospital RP (Interv'n)	Home RP (ConsM)	Oximetry (ConsM)	Hospital RP (ConsM)	Screening (ConsM)
Prevalence estimate of OSAHS is higher	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Oximetry (Interv'n)	Hospital RP (ConsM)	Screening (ConsM)	Oximetry (ConsM)
Other								

Analysis	Rank of net monetary benefit at £20,000 per QALY gained							
	1	2	3	4	5	6	7	8
CV treatment effect also applies to mild OSAHS	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Oximetry (Interv'n)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
False positives continue with treatment beyond 12 months	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Oximetry (Interv'n)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
Patients diagnosed with mild OSAHS receive 100% CPAP	Screening (Interv'n)	Home RP (Interv'n)	Oximetry (Interv'n)	Hospital RP (Interv'n)	Home RP (ConsM)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
Patients diagnosed with mild OSAHS receive 50% bespoke oral devices and 50% CPAP	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Oximetry (Interv'n)	Home RP (ConsM)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
Patients diagnosed with mild OSAHS receive 50% conservative management and 50% CPAP	Home RP (Interv'n)	Screening (Interv'n)	Hospital RP (Interv'n)	Oximetry (Interv'n)	Home RP (ConsM)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)
Low Home RP costs	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Home RP (ConsM)	Oximetry (Interv'n)	Hospital RP (ConsM)	Screening (ConsM)	Oximetry (ConsM)
High Home RP costs	Home RP (Interv'n)	Hospital RP (Interv'n)	Screening (Interv'n)	Oximetry (Interv'n)	Home RP (ConsM)	Hospital RP (ConsM)	Oximetry (ConsM)	Screening (ConsM)

*ConsM=Conservative management, CPAP=continuous passive airway pressure, INMB=Incremental net monetary benefit, QALY=quality-adjusted life-year, RP=respiratory polygraphy, RTA=road traffic accident, * at £20,000 per QALY gained*

Table 19; Cost (£) per QALY gained for selected treatment comparisons - Sensitivity analyses

Analysis	Cost per QALY gained		
	Home RP (ConsM) vs Oximetry (ConsM)	Home RP (Interv'n) vs Home RP (Cons M)	Hospital RP (Interv'n) vs Home RP (Interv'n)
Basecase results	10,685	10,757	43,630
Diagnostic accurasy of strategies			
Misdiagnosis threshold for no OSA and moderate/severe OSA	14,552	10,204	751,471
Retest turned off in model (all diagnostic strategies except screening)	9,844	10,704	39,684
Retest correlation of 20%	10,178	10,701	43,562

Analysis	Cost per QALY gained		
	Home RP (ConsM) vs Oximetry (ConsM)	Home RP (Interv'n) vs Home RP (Cons M)	Hospital RP (Interv'n) vs Home RP (Interv'n)
Retest correlation of 40%	9,947	10,677	42,321
Home oximetry diagnostic meta-analysis includes Pataka 2016	10,749	10,711	44,099
Diagnostic strategies			
Retest strategy for oximetry and home RP is Hospital RP	9,544	10,671	43,930
1st test in screening strategy home RP	10,450	10,688	44,053
2nd test in screening strategy hospital RP	10,611	10,782	44,472
1st test in screening strategy home RP, second test hospital RP	10,629	10,743	43,222
Polysomnography after second test for all False Negatives with underlying moderate/severe disease	10,539	10,714	42,589
Polysomnography after first test for all False Negatives with underlying moderate/severe disease	9,540	10,674	44,390
Treatment more cost effective			
CPAP ESS effect is based on ESS subgroup (not AHI subgroup)	8,195	10,011	30,876
Reduce CPAP dropout rate 20%	10,528	10,713	42,264
NHS and police costs	9,771	9,805	43,423
CPAP device lower cost	9,855	10,283	42,752
CPAP device and staff costs for education and setup are lower	9,567	10,072	42,796
All of the above (treatment more cost effective)	6,869	8,566	28,708
Treatment less cost effective			
Increase CPAP drop out rate 20%	10,590	10,687	45,342
High CPAP cost: auto-CPAP with telemonitoring	12,116	11,668	45,908
CPAP lifetime 5 years	10,900	10,946	44,550
Turn off RTA treatment effects	12,532	13,280	46,172
Turn off CV treatment effects	10,742	10,744	45,008
Turn off CV and RTA treatment effects	12,988	13,551	46,636

Analysis	Cost per QALY gained		
	Home RP (ConsM) vs Oximetry (ConsM)	Home RP (Interv'n) vs Home RP (Cons M)	Hospital RP (Interv'n) vs Home RP (Interv'n)
All of the above (treatment less cost effective)	15,640	15,188	52,916
Cohort			
Low starting age of 30 years	8,880	9,148	34,410
High starting age of 80 years	15,824	13,272	107,579
Higher risk profile	10,921	11,134	47,662
Lower risk profile	10,598	10,807	41,201
Prevalence estimate of OSAHS is lower	12,742	11,581	64,530
Prevalence estimate of OSAHS is higher	10,239	10,569	42,177
Other			
CV treatment effect also applies to mild OSAHS	10,543	10,607	43,867
False positives continue with treatment beyond 12 months	10,542	10,728	43,373
Patients diagnosed with mild OSAHS receive 100% CPAP	10,599	8,622	Dominated
Patients diagnosed with mild OSAHS receive 50% bespoke oral devices and 50% CPAP	10,509	10,625	58,403
Patients diagnosed with mild OSAHS receive 50% conservative management and 50% CPAP	10,415	8,599	55,451
Low Home RP costs	9,362	10,712	52,575
High Home RP costs	11,290	10,718	38,057

ConsM=Conservative management, CPAP=continuous passive airway pressure, INMB=Incremental net monetary benefit, QALY=quality-adjusted life-year, RP=respiratory polygraphy, RTA=road traffic accident

1.5.6. Health economic evidence statements

- A cost-utility analysis found that polysomnography was not cost effective compared with home respiratory polygraphy for diagnosing OSAHS (£113,800 per QALY gained). This was assessed as partially applicable with minor limitations.
- An original cost-utility analysis for symptomatic people suspected of having OSAHS, found that when only moderate and severe OSAHS is treated with CPAP and those with mild OSAHS receive conservative management:
  - home respiratory polygraphy was cost effective compared with home oximetry (£10,600 per QALY gained).
  - hospital respiratory polygraphy was not cost effective compared with home respiratory polygraphy (£32,000 per QALY gained).
  - hospital respiratory polygraphy was cost effective compared with home oximetry (£15,600 per QALY gained).
  - Screening with home oximetry and then re-testing negatives with home respiratory polygraphy was cost effective at £30,000 per QALY but not at £20,000 per QALY compared with home oximetry alone (£24,200 per QALY gained).

  This was assessed as partially applicable with potentially serious limitations.
- An original cost-utility analysis for symptomatic people suspected of having OSAHS found that when 1/3 of people with mild OSAHS receive CPAP, 1/3 receive MAS and the remaining 1/3 receive conservative management:
  - home respiratory polygraphy was cost effective compared with home oximetry (£9,600 per QALY gained).
  - hospital respiratory polygraphy was not cost effective compared with home respiratory polygraphy (£43,630 per QALY gained).
  - hospital respiratory polygraphy was cost effective compared with home oximetry (£14,900 per QALY gained).
  - Screening with home oximetry and then re-testing negatives with home respiratory polygraphy was cost effective compared with home oximetry alone (£12,800 per QALY gained).

  This was assessed as partially applicable with potentially serious limitations.

1.6. The committee's discussion of the evidence

1.6.1. Interpreting the evidence

1.6.1.1. The diagnostic measures that matter most

Diagnostic tests

The committee reviewed the evidence on sensitivity and specificity of the various and tests. Specificity was considered most important as these tests could potentially be used in lieu of polysomnography for a final diagnosis.

All diagnostic tests (home oximetry, home RP, hospital RP) were stratified by severity as: all OSAHS (AHI≥5); moderate-severe OSAHS (AHI ≥15); severe OSAHS (AHI ≥30).

1.6.1.2. The quality of the evidence

OSAHS

Diagnostic tests

There was evidence from twenty three diagnostic accuracy studies: two studies for home oximetry (all severities OSAHS) included 73 and 84 participants respectively; three studies for home oximetry (moderate-severe OSAHS) with population size ranging from 69 to 98 participants; eight studies for home respiratory polygraphy (all severities OSAHS) with population size ranging from 37 to 348 participants; four studies for home respiratory polygraphy (moderate to severe OSAHS) including from 75 to 348 participants; four studies of home respiratory polygraphy (severe OSAHS) with population ranging from 43 to 128 participants; eight studies for hospital-based respiratory polygraphy (all severities OSAHS) with populations ranging from 43 to 80 participants; five studies for hospital-based respiratory polygraphy (moderate to severe OSAHS) with populations ranging from 42 to 80 participants; and three studies for hospital-based respiratory polygraphy (severe OSAHS) with populations ranging from 43 to 80 participants.. All studies included in the diagnostic accuracy review used polysomnography as the reference standard.

There was evidence from one medium size RCT (test and treat study) which included 430 participants comparing home respiratory polygraphy with polysomnography in moderate OSAHS.

The quality of evidence for diagnostic accuracy studies varied from moderate to very low quality; the majority of evidence was downgraded due to risk of bias, imprecision, indirectness and inconsistency. Risk of bias was most commonly due to selection bias. The committee also acknowledged that some uncertainty existed across the effect sizes seen within the evidence, with some confidence intervals crossing the MID thresholds or line of no effect. Indirectness was due to the AHI used in the studies not corresponding exactly to the AHI levels stipulated in our protocol (see section 1.4.1 above). Inconsistency was found in majority of comparisons (home oximetry all OSAHS (AHI ≥ 5) population, home respiratory polygraphy all OSAHS (AHI ≥5), moderate-severe OSAHS (AHI ≥ 15) and severe OSAHS (AHI ≥ 30) populations, hospital respiratory polygraphy all OSAHS (AHI ≥5), moderate-severe OSAHS (AHI ≥ 15) and severe OSAHS (AHI ≥ 15) populations). For inconsistency,the evidence was downgraded by 1 increment if the individual studies varied across 2 areas [(for example, 50–90% and 90–100%)] and by 2 increments if the individual studies varied across 3 areas [(for example, 0–50%, 50–90% and 90–100%)]. Subgroup analysis could not be conducted because there was no sufficient information (BMI or coexisting conditions) to conduct a subgroup analysis.. The committee took quality of the evidence in to account while interpreting the evidence for decision making.

The committee considered the clinical importance of AHI (test and treat study) on a case by case basis, taking into consideration the baseline AHI and the improvement in severity of sleep apnoea.

The quality of evidence for RCT (test and treat study) was moderate to very low due to risk of bias and imprecision. Risk of bias was most commonly due to selection bias and performance bias. The committee also acknowledged that some uncertainty existed across the effect sizes seen within the evidence, with some confidence intervals crossing the MID thresholds or line of no effect. The committee took quality of the evidence in to account while interpreting the evidence for decision making.

The committee noted that there was no formal chronological cut-off for the review, but technology is likely to have improved over the period of time studied in the included publications. However, there is no sharp demarcation in time, at which point it would be inappropriate to consider evidence and the improvement is likely to be seen with all the technical testing devices roughly to the same degree.

OHS

There was no evidence identified that assessed diagnostic tests forOHS.

COPD-OSAHS overlap syndrome

There was evidence from one diagnostic accuracy study in people with suspected COPD-OSAHS overlap syndrome. The study assessed the accuracy of hospital respiratory polygraphy (all severities COPD-OSAHS overlap syndrome) with 33 included participants, hospital respiratory polygraphy (moderate - severe COPD-OSAHS overlap syndrome) with 33 included participants and hospital respiratory polygraphy (severe COPD-OSAHS overlap syndrome) with 33 included participants. The study included in the diagnostic accuracy review used polysomnography as the reference standard.The quality of evidence for diagnostic accuracy studies varied from low to very low; the majority of evidence was downgraded due to risk of bias or imprecision. Risk of bias was most commonly due to selection bias. The committee also acknowledged that some uncertainty existed across the effect sizes seen within the evidence, with some confidence intervals crossing the MID thresholds or line of no effect. Indirectness was due to proxy AHI used in the studies. The committee took quality of the evidence in to account while interpreting the evidence for decision making.

1.6.1.3. Benefits and harms

OSAHS

Home oximetry (diagnostic accuracy studies)

The evidence from two studies reporting the diagnostic accuracy of home oximetry for all OSAHS population (AHI≥5) with a reference standard of hospital polysomnography showed low sensitivity [51.81% (8.2 to 92.2%)] and high specificity [95.83% (15.31 to 99.99%)], with very serious uncertainty around both sensitivity and specificity. The studies also had serious limitations as they excluded people with heart failure, respiratory insufficiency, COPD and anaemia. The committee agreed that this was important because these are relatively common conditions. Dips in arterial oxygen saturation are seen in these patient groups for reasons other than OSAHS, such as: artefacts, movement, and desaturation in those with baseline hypoxaemia due to a normal degree of hypoventilation, particularly in rapid eye movement sleep. These oxygen dips would reduce the diagnostic accuracy of oximetry by reducing its specificity and lead to an increase in the number of false positive results. It is also possible that people with OSAHS and only mild or minimal nocturnal desaturation would be missed, e.g. using a 4% oxygen desaturation cut-off rate. The committee noted that this could be one of the reasons for low sensitivity and took this in to account while interpreting the evidence. They agreed that it is important clinically, as the clinicians will need to to have confidence to reassure people their study results are normal

The evidence from three studies reporting the diagnostic accuracy of home oximetry in a moderate-severe population (AHI≥15) showed low sensitivity [35.02% (12.98 to 65.24%)] and high specificity [99.44% (95.35 to 99.98%)].It was noted by the committee that there was serious uncertainty around sensitivity. The committee discussed that the results were counterintuitive, as it is commonly understood that detecting moderate-severe OSAHS (AHI≥15-30) is easier than detecting mild OSAHS (AHI≥5) using home oximetry.

There was no evidence reporting home oximetry for severe OSAHS population (AHI≥30).

The committee agreed that the inconsistency observed in a number of the outcomes in home oximetry was not surprising as different studies used slightly different cut-offs for the index and reference test.

Home respiratory polygraphy (diagnostic accuracy studies)

The evidence from eight studies reporting the diagnostic accuracy for home respiratory polygraphy for all OSAHS population (AHI≥5) showed high sensitivity [94.65% (89.81 to 97.36%)] and moderate specificity [57.69% (39.87 to 74.41%)], with serious uncertainty for both sensitivity and specificity. The evidence from four studies reporting the diagnostic accuracy for home respiratory polygraphy for a moderate-severe OSAHS population

(AHI≥15) showed high sensitivity [84.2% (59.67 to 95.87%)] and high specificity [88.95% (71.07 to 96.56%)], with very serious uncertainty around sensitivity and serious uncertainty around specificity.

The evidence from three studies reporting the diagnostic accuracy for home respiratory polygraphy in a severe OSAHS population (AHI≥30) showed moderate sensitivity [64.25% (28.6 to 89.74%)] and high specificity [92.06% (68.46to 98.28%)], with very serious uncertainty around sensitivity and serious uncertainty around specificity.

The committee noted that there was an inverse relationship between sensitivity and specificity of home respiratory polygraphy in OSAHS population as sensitivity decreased and specificity increased with with higher cut-off points.

Home respiratory polygraphy RCT (test and treat studies)

The test and treat evidence showed that regardless of accuracy, a home respiratory polygraphy-based approach resulted in equivalent clinical outcomes to in centre polysomnography-based approach to diagnosis.

There was no clinically important difference for EQ5D, FOSQ, SF 36 physical and mental components, Epworth sleepiness scale, AHI, change in systolic blood pressure.The number of people given CPAP per thousand was lower in the home respiratory polygraphy group compared to the polysomnography group.The committee acknowledged that some uncertainty existed across the effect sizes seen within the evidence. The committee also noted that this evidence was only reported at 6 months and longer-term results were not available.

Hospital respiratory polygraphy (diagnostic accuracy studies)

The evidence from eight studies reporting the diagnostic accuracy for hospital respiratory polygraphy for all OSAHS population (AHI≥5) showed high sensitivity [94.68% (87.61 to 98.61%)] and moderate specificity of [81.39% (57.46 to 92.48%)] with serious uncertainty around sensitivity and very serious uncertainty around specificity.

The evidence from five studies reporting the diagnostic accuracy for hospital respiratory polygraphy for a moderate-severe OSAHS population (AHI≥15) showed high sensitivity [93.22% (81.09 to 98.39)] and high specificity [92.57% (82.79 to 97.5%)], with serious uncertainty around both sensitivity and specificity.

The evidence from four studies reporting the diagnostic accuracy for hospital respiratory polygraphy for a severe OSAHS population (AHI≥30) showed high sensitivity [94.35% (74.35 to 99.28%)] and moderate specificity [92.59% (1.8 to 99.99%)], with serious uncertainty around sensitivity and very serious uncertainty around specificity.

The committee noted that specificity of hospital respiratory polygraphy in OSAHS population increased with higher cut-off points. However even though the sensitivity was highest fo all severities OSAHS (AHI≥5) at 94.68% it was very similar to sensitivity for severe OSAHS population (AHI≥30) at 94.35%. Interestingly the lowest sensitivity was for moderate-severe OSAHS population at 93.22%.

COPD-OSAHS overlap syndrome

Hospital respiratory polygraphy (diagnostic accuracy studies)

The evidence from one study reporting the diagnostic accuracy for hospital respiratory polygraphy for all COPD-OSAHS overlap population (AHI≥5) showed high sensitivity [96% (79 to 100%)] and moderate specificity [56% (21 to 86%)], with serious uncertainty around both sensitivity and specificity.

The evidence from one study study reporting the diagnostic accuracy for hospital respiratory polygraphy for moderate-severe COPD-OSAHS overlap population (AHI≥15) showed moderate sensitivity [77%(46 to 95%)] and high specificity [90% (68 to 99%)], with very serious uncertainty around sensitivity and serious uncertainty around specificity.

The evidence from one study study reporting the diagnostic accuracy for hospital respiratory polygraphy for severe COPD-OSAHS overlap population (AHI≥30) showed moderate sensitivity [89%(52 to 100%)] and high specificity [96% (79 to 100%)], with very serious uncertainty around sensitivity and serious uncertainty around specificity.

The committee noted that specificity of hospital respiratory polygraphy in COPD-OSAHS overlap population increased with higher cut-off points. However the sensitivity was highest for all severities COPD - OSAHS (AHI≥5) at 96% and lowest for moderate-severe COPD-OSAHS population (AHI≥15) at 77% with sensitivity for severe COPD-OSAHS overlap population (AHI≥15) at 89%.

Diagnostic tests -committee's consideration of the evidence to make recommendations

OSAHS

The evidence on diagnostic tests for OSAHS was not consistent. The studies reviewed looked at diagnostic devices with a variety of monitoring channels and included different patient groups. The committee also noted that diagnostic equipment has evolved and improved over time. The committee used their clinical knowledge and experience, supported by the published evidence and by the economic model developed for this guideline to make the recommendations.

The evidence overall favoured both home and hospital respiratory polygraphy as the first-line diagnostic test most likely to give an accurate result without retesting. The committee noted that respiratory polygraphy has the added benefit of aiding the diagnosis of other conditions such as central sleep apnoea and nocturnal hypoventilation and it is better than oximetry alone in identifying artefacts in the recordings.

The committee agreed that hospital respiratory polygraphy may sometimes be needed when investigating alternative diagnoses alongside OSAHS, because extra monitoring channels can be utilised. It might also be an option if home respiratory polygraphy is impractical, for example in people who need help with the monitoring equipment, or need to travel long distances to pick up and return devices, or when a number of inpatient investigations need to be combined.

The committee agreed that oximetry may be particularly inaccurate in people with common conditions such as heart failure or chronic lung disease which can result in desaturation without the presence of OSAHS, and oximetry cannot reliably distinguish between obstructive apnoeas and hypoventilation, which is important to help determine treatment. However, diagnostic strategies incorporating oximetry are still used, for example by sites at which the volume of referrals exceeds the availability of home polygraphy equipment. The committee recognised that it might take time to change this practice. They also noted that in cases in which a priori suspicion of OSAHS is low, normal oximetry provides further evidence against the diagnosis and therefore did not think it appropriate to recommend definitively against its use, but agreed that it was important to make a recommendation highlighting the potential problems of reliance on oximetry.

Polysomnography was the reference standard for the tests included in the review. The committee agreed that further investigation with polysomnography, which is more accurate and more expensive than respiratory polygraphy, should be an option to provide more detail

on sleep fragmentation and respiratory events for people with symptoms of OSAHS who have a negative respiratory polygraphy result but continue to have suggestive symptoms. This may help distinguish between OSAHS and other disorders such as narcolepsy, REM sleep behaviour disorder, periodic limb movement disorders, idiopathic hypersomnolence or parasomnia which are suspected as a more likely diagnosis for the person's symptoms, or help diagnose these disorders when they are suspected in addition to OSAHS.

Even though there was a lack of evidence for diagnostic tests for OSAHS, based on their experience the committee made strong recommendations hence they did not make any research recommendation for these tests.

Current practice is variable, with some sleep centres offering oximetry as the first-line test and others offering home respiratory polygraphy. The recommendations will help reduce this variation. Some centres will need to provide more home respiratory equipment and less home oximetry but this should lead to fewer repeat tests and optimal treatment.

OHS

There was no evidence for diagnostic tests for people with suspected OHS, so the committee used their clinical knowledge and experience to make the recommendations.

OHS is characterised by obesity with a BMI over 30 kg/m^2 and daytime hypercapnia with a PaCO2 >6kPa.

Diagnosing OHS

OHS is one specific cause of chronic ventilatory failure, and by definition a measurement of PaCO2 from arterial or arterialised capillary blood gas, taken while the person with suspected OHS is awake, is needed to establish the diagnosis. It is current practice to measure these and although they are invasive tests obtaining the samples is generally straightforward.

The committee discussed the use of serum venous bicarbonate measurements and recognised that these may be helpful in people with suspected OHS as a preliminary test. Serum bicarbonate indirectly reflects medium and long-term PaCO2 levels and is a simpler and less painful test than blood gas measurement and a normal level is helpful in ruling out OHS if the probability of diagnosis low.. The committee therefore agreed that it could be recommended in such cases, but noted that this alone will not completely rule out OHS and that other tests are needed when clinical suspicion is high.

People with any form of chronic ventilatory failure can readily develop acute ventilatory failure if, for example, they have an intercurrent respiratory tract infection. Acute ventilatory failure is a medical emergency needing urgent treatment, and the committee agreed it is important to state that this should take priority over full investigation of any underlying chronic disease.

Diagnosing the presence of OSAHS or nocturnal hypoventilation in OHS

The committee agreed that diagnosis of concomitant OSAHS is required to ensure optimal treatment, and that this should be with either hospital or home respiratory polygraphy based on their experience and the evidence for diagnosis of OSAHS in people without OHS.

The committee agreed that transcutaneous CO_2 monitoring should also be considered at the same time, to help establish the severity of nocturnal hypoventilation.A markedly raised CO_2

level suggests non-invasive ventilation may be the treatment of choice rather than CPAP and the committee agreed this should be considered.

The committee agreed that oximetry alone as a diagnostic test is insufficient for diagnosis because it does not clearly distinguish between obstructive apnoeas and nocturnal hypoventilation. With this in mind the committee made a recommendation to not use oximetry alone to determine the presence of OSAHS in people with OHS.

The committee noted that the recommendations reflect current practice and would therefore not be expected to increase NHS cost.

Even though there was a lack of evidence for respiratory polygraphy, oximetry, arterial or arterialised capillary blood gas, transcutaneous CO2 and serum venous bicarbonate, based on their experience the committee made strong recommendations hence they did not make any research recommendation for these tests.

There was no evidence for hospital oxycapnography and home oxycapnography, the committee agreed not make a recommendation or research recommendation for these tests as they are not routinely used in diagnostic clinical practice in most centres.

COPD-OSAHS overlap syndrome

There was limited evidence from one small study for diagnostic tests in people with COPD–OSAHS overlap syndrome, suggesting that respiratory polygraphy has reasonable sensitivity and specificity in making the diagnosis. COPD and OSAHS are both common conditions and the committee were able to use their clinical knowledge and experience in addition to the formal evidence in making recommendations.

Diagnosing ventilatory failure

Ventilatory failure is a common in COPD and causes severe exacerbations of chronic obstructive pulmonary disease (COPD). Measurement of PaCO2 from arterial or arterialised capillary blood gas, taken while the person with suspected COPD-OSAHS overlap syndrome is awake, is needed to establish the diagnosis. It is current practice to measure these and although they are invasive tests obtaining the samples is generally straightforward.

People with any form of chronic ventilatory failure can readily develop acute ventilatory failure if, for example, they have an intercurrent respiratory tract infection. Acute ventilatory failure is a medical emergency needing urgent treatment, and the committee agreed it important to state that this should take take priority over full investigation of any underlying chronic disease.

The committee agreed that arterial blood gas and arterialised capillary blood gas measurements give precise information about oxygen and carbon dioxide levels and information about acid base balance at the point in time they are taken.

Diagnosing the presence of OSAHS or nocturnal hypoventilation in COPD-OSAHS overlap syndrome

The committee agreed that respiratory polygraphy (either in hospital or at home) should be recommended to establish the presence of OSAHS and nocturnal hypoventilation and also to help determine the most suitable treatment (i.e. non-invasive ventilation/CPAP), based on the evidence for OSAHS alone (see above) plus the small study directly addressing COPD-OSAHS overlap syndrome. The committee agreed that transcutaneous CO_2 monitoring with respiratory polygraphy should also be considered to help confirm nocturnal hypoventilation and severity of hypercapnia. Adding transcutaneous CO_2 monitoring with respiratory polygraphy may also help to define the relative contributions of COPD and OSAHS and

therefore guide treatment choices and titration of settings. The committee noted that while transcutaneous CO2 monitoring can be carried out at home, this is not routinely incorporated into level 3 diagnostic devices, requires more frequent calibration and therefore a measure of CO2 is usually carried out as part of an in-hospital RP. The person needs to have stable COPD, without a recent exacerbation, before a clear diagnosis can be established.

The committee agreed that oximetry alone should not be used to diagnose OSAHS in this population because people with COPD are more likely to have a degree of hypoxaemia when awake, and therefore more easily exhibit falls in oxygen saturation level when asleep, making identification of apnoea episodes more difficult.

As with people with OHS, those with COPD-OSAHS overlap syndrome may present in acute ventilatory failure is a medical emergency requiring urgent treatment, and this must take priority over full investigation of any underlying chronic disease.

The committee stated that the recommendations reflect current actual practice.

Even though there was a lack of evidence for diagnostic tests for COPD-OSAHS overlap syndrome, based on their experience the committee made strong recommendations hence they did not make any research recommendation for these tests.

1.6.2. Cost effectiveness and resource use

One economic evaluation was included in this review, which evaluated the cost-effectiveness of polysomnography (PSG) compared to home respiratory polygraphy (RP) in patients suspected of OSAHS.[93] This study, conducted in Spain with costings from a Spanish health care perspective, found that PSG was not cost-effective when compared to home RP. The committee explained that current practice has evolved to perform PSG tests only when they were necessary, due to their high costs. This would include patients who remain symptomatic despite a negative respiratory polygraphy.

Some regions have used simple oximetry as a first line strategy to diagnose OSAHS due to its low costs. However, the committee noted the low sensitivity of this test compared to the home RP, and the negative long-term health outcomes (cardiovascular events and road traffic accidents) associated with a false negative diagnosis.

An original cost-utility analysis was constructed to evaluate the cost effectiveness of home RP compared to both home oximetry and in-hospital RP for patients suspected of having OSAHS, using the diagnostic accuracy evidence from the guideline's systematic review. In the model, the benefits of a successful diagnosis were improved health-related quality of life and also a reduced incidence of road traffic accidents and (for moderate or severe OSAHS) reduced cardiovascular events.

The same decision model was used to evaluate different treatments for mild OSAHS. In those analyses, CPAP was the most cost effective strategy for mild OSAHS (see Evidence report E). CPAP was also the treatment of choice for moderate and severe OSAHS on the basis of NICE technology appraisal TA139.

The diagnostic strategy with the greatest QALYs gained was Hospital RP with intervention. At a threshold of £20,000 per QALY, Home RP with intervention for mild OSAHS was the most cost effective strategy.

The committee noted some limitations with this analysis:

- The studies in the diagnostic accuracy review, on which this model was based, typically excluded people with heart failure or lung disease such as COPD. Had this not been the case, then the specificity observed might have been lower, since people

with these conditions can experience drops in oxygen in the absence of OSAHS. For this reason, the specificity of oximetry in the model might have been over-estimated.

- Due to lack of evidence, the model pathway is not well developed for true negatives and false positives. We did not find evidence for the prevalence of alternative diagnoses in the relevant population and hence the model did not capture the health consequences of false positive diagnoses. Nor did it capture the cost of subsequent treatment for both true negatives and false negatives. Since home RP can assist in diagnosing other conditions (such as central sleep apnoea and nocturnal hypoventilation), there are likely to be additional benefits associated with home RP that are not captured in the model.

The committee concluded that home RP is the most cost effective first-line diagnostic test for diagnosing OSAHS and therefore they recommended it. The second most cost effective test was in-hospital RP, so the committee recommended this for occasions when home respiratory polygraphy is not feasible. However, they noted that due to the risk of transmitting infectious disease its use should be avoided wherever possible. The model did not evaluate the use of polysomnography per se but when in a sensitivity analysis it was added in to the model as a 3rd line test, it did not change the ranking of the strategies.

Finally, the committee made consensus recommendations for the OHS and COPD-OSAHS overlap syndrome populations based on their clinical expertise, as there was no clinical or economic evidence available to steer recommendations. The consensus recommendations in the OHS and overlap syndrome populations ensure that the NHS has some guidance from the committee based on what is occurring in practice. Blood gas measurement is recommended to diagnose OHS. It is also recommended for assesing ventilatory failure in people with suspected COPD–OSAHS overlap syndrome. This is a commonly used and relatively low cost test. The committee agreed that transcutaneous CO_2 monitoring should also be considered for people with OHS or COPD–OSAHS overlap syndrome as this is useful to confirm nocturnal hypercapnia, which might indicate if non-invasive ventilation is required. This might require the use of in-hospital RP rather than home RP.

1.6.3. Other factors the committee took into account

The committee noted that home testing would be preferred by most people as it reduces the need for them to attend hospital, and they are more likely to have typical sleep episodes at home.

References

1. Aaronson JA, Nachtegaal J, van Bezeij T, Groet E, Hofman WF, van den Aardweg JG et al. Can a prediction model combining self-reported symptoms, sociodemographic and clinical features serve as a reliable first screening method for sleep apnea syndrome in patients with stroke? Archives of Physical Medicine and Rehabilitation. 2014; 95(4):747-752

2. Aaronson JA, van Bezeij T, van den Aardweg JG, van Bennekom CA, Hofman WF. Diagnostic accuracy of nocturnal oximetry for detection of sleep apnea syndrome in stroke rehabilitation. Stroke. 2012; 43(9):2491-2493

3. Abad J, Munoz-Ferrer A, Cervantes MA, Esquinas C, Marin A, Martinez C et al. Automatic video analysis for obstructive sleep apnea diagnosis. Sleep. 2016; 39(8):1507-1515

4. Abdelghani A, Chambille B, Alfandary D, Feigel P, Nedelcoux H, Lanoe JL et al. A cost-effective two-step strategy for the diagnosis of sleep apnoea syndrome. Somnologie. 2004; 8(4):139-145

5. Abdeyrim A, Li N, Shao L, Heizhati M, Wang Y, Yao X et al. What can impulse oscillometry and pulmonary function testing tell us about obstructive sleep apnea: A case-control observational study? Sleep & Breathing. 2016; 20(1):61-68

6. Abdeyrim A, Tang L, Muhamat A, Abudeyrim K, Zhang Y, Li N et al. Receiver operating characteristics of impulse oscillometry parameters for predicting obstructive sleep apnea in preobese and obese snorers. BMC Pulmonary Medicine. 2016; 16(1):125

7. Abdeyrim A, Zhang Y, Li N, Zhao M, Wang Y, Yao X et al. Impact of obstructive sleep apnea on lung volumes and mechanical properties of the respiratory system in overweight and obese individuals. BMC Pulmonary Medicine. 2015; 15:76

8. Abdullah B, Idris AI, Mohammad ZW, Mohamad H. Validation of Bahasa Malaysia STOP-BANG questionnaire for identification of obstructive sleep apnea. Sleep & Breathing. 2018; 22(4):1235-1239

9. Abeyratne UR, de Silva S, Hukins C, Duce B. Obstructive sleep apnea screening by integrating snore feature classes. Physiological Measurement. 2013; 34(2):99-121

10. Abeyratne UR, Wakwella AS, Hukins C. Pitch jump probability measures for the analysis of snoring sounds in apnea. Physiological Measurement. 2005; 26(5):779-798

11. Abraham WT, Trupp RJ, Phillilps B, Bourge RC, Bailey B, Harding SM et al. Validation and clinical utility of a simple in-home testing tool for sleep-disordered breathing and arrhythmias in heart failure: Results of the Sleep Events, Arrhythmias, and Respiratory Analysis in Congestive Heart Failure (SEARCH) study. Congestive Heart Failure. 2006; 12(5):241-247; quiz 248-249

12. Abrahamyan L, Sahakyan Y, Chung S, Pechlivanoglou P, Bielecki J, Carcone SM et al. Diagnostic accuracy of level IV portable sleep monitors versus polysomnography for obstructive sleep apnea: A systematic review and meta-analysis. Sleep & Breathing. 2018; 22(3):593-611

13. Abrishami A, Khajehdehi A, Chung F. A systematic review of screening questionnaires for obstructive sleep apnea. Canadian Journal of Anaesthesia. 2010; 57(5):423-438

14. Abumuamar AM, Dorian P, Newman D, Shapiro CM. The STOP-BANG questionnaire shows an insufficient specificity for detecting obstructive sleep apnea in patients with atrial fibrillation. Journal of Sleep Research. 2018; 27(6):e12702

15. Acharya UR, Chua EC, Faust O, Lim TC, Lim LF. Automated detection of sleep apnea from electrocardiogram signals using nonlinear parameters. Physiological Measurement. 2011; 32(3):287-303

16. Adachi H, Mikami A, Kumano-go T, Suganuma N, Matsumoto H, Shigedo Y et al. Clinical significance of pulse rate rise during sleep as a screening marker for the assessment of sleep fragmentation in sleep-disordered breathing. Sleep Medicine. 2003; 4(6):537-542

17. Adams RJ, Appleton SL, Vakulin A, Lang C, Martin SA, Taylor AW et al. Association of daytime sleepiness with obstructive sleep apnoea and comorbidities varies by sleepiness definition in a population cohort of men. Respirology. 2016; 21(7):1314-1321

18. Ahmadi N, Chung SA, Gibbs A, Shapiro CM. The Berlin questionnaire for sleep apnea in a sleep clinic population: relationship to polysomnographic measurement of respiratory disturbance. Sleep & Breathing. 2008; 12(1):39-45

19. Akhter S, Abeyratne UR, Swarnkar V, Hukins C. Snore sound analysis can detect the presence of obstructive sleep apnea specific to NREM or REM sleep. Journal of Clinical Sleep Medicine. 2018; 14(6):991-1003

20. Alakuijala A, Salmi T. Predicting obstructive sleep apnea with periodic snoring sound recorded at home. Journal of Clinical Sleep Medicine. 2016; 12(7):953-958

21. Alchakaki A, Riehani A, Shikh-Hamdon M, Mina N, Badr MS, Sankari A. Expiratory snoring predicts obstructive pulmonary disease in patients with sleep-disordered breathing. Annals of the American Thoracic Society. 2016; 13(1):86-92

22. Alhouqani S, Al Manhali M, Al Essa A, Al-Houqani M. Evaluation of the Arabic version of STOP-Bang questionnaire as a screening tool for obstructive sleep apnea. Sleep & Breathing. 2015; 19(4):1235-1240

23. Almazaydeh L, Elleithy K, Faezipour M. Obstructive sleep apnea detection using SVM-based classification of ECG signal features. 2012 Annual International Conference of the IEEE Engineering in Medicine and Biology Society, San Diego, CA,. 2012; 2012:4938-4941

24. Alonso Alvarez MD, Santos JT, Guevara JC, Martinez MG, Pascual LR, Banuelos JL et al. Reliability of home respiratory polygraphy for the diagnosis of sleep apnea-hypopnea syndrome: Analysis of costs. Archivos de Bronconeumologia. 2008; 44(1):22-28

25. Alshaer H, Fernie GR, Maki E, Bradley TD. Validation of an automated algorithm for detecting apneas and hypopneas by acoustic analysis of breath sounds. Sleep Medicine. 2013; 14(6):562-571

26. Alshaer H, Fernie GR, Tseng WH, Bradley TD. Comparison of in-laboratory and home diagnosis of sleep apnea using a cordless portable acoustic device. Sleep Medicine. 2016; 22:91-96

27. Alvarez D, Cerezo-Hernandez A, Crespo A, Gutierrez-Tobal GC, Vaquerizo-Villar F, Barroso-Garcia V et al. A machine learning-based test for adult sleep apnoea screening at home using oximetry and airflow. Scientific Reports. 2020; 10(1):5332

28. Alvarez D, Gutierrez GC, Marcos JV, Del Campo F, Hornero R. Spectral analysis of single-channel airflow and oxygen saturation recordings in obstructive sleep apnea detection. 2010 Annual International Conference of the IEEE Engineering in Medicine and Biology, Buenos Aires. 2010; 2010:847-850

29. Alvarez D, Hornero R, Abasolo D, del Campo F, Zamarron C. Nonlinear characteristics of blood oxygen saturation from nocturnal oximetry for obstructive sleep apnoea detection. Physiological Measurement. 2006; 27(4):399-412

30. Alvarez D, Hornero R, Abasolo D, del Campo F, Zamarron C, Lopez M. Nonlinear measure of synchrony between blood oxygen saturation and heart rate from nocturnal pulse oximetry in obstructive sleep apnoea syndrome. Physiological Measurement. 2009; 30(9):967-982

31. Alvarez D, Hornero R, Garcia M, del Campo F, Zamarron C. Improving diagnostic ability of blood oxygen saturation from overnight pulse oximetry in obstructive sleep apnea detection by means of central tendency measure. Artificial Intelligence in Medicine. 2007; 41(1):13-24

32. Alvarez D, Hornero R, Garcia M, del Campo F, Zamarron C, Lopez M. Cross approximate entropy analysis of nocturnal oximetry signals in the diagnosis of the obstructive sleep apnea syndrome. 2006 International Conference of the IEEE Engineering in Medicine and Biology Society, New York, NY. 2006; 2006:6149-6152

33. Amra B, Javani M, Soltaninejad F, Penzel T, Fietze I, Schoebel C et al. Comparison of Berlin Questionnaire, STOP-Bang, and Epworth Sleepiness Scale for diagnosing obstructive sleep apnea in persian patients. International Journal of Preventive Medicine. 2018; 9(1):28

34. Amra B, Nouranian E, Golshan M, Fietze I, Penzel T. Validation of the persian version of berlin sleep questionnaire for diagnosing obstructive sleep apnea. International Journal of Preventive Medicine. 2013; 4(3):334-339

35. Amra B, Rahmati B, Soltaninejad F, Feizi A. Screening questionnaires for obstructive sleep apnea: An updated systematic review. Oman Medical Journal. 2018; 33(3):184-192

36. Andres-Blanco AM, Alvarez D, Crespo A, Arroyo CA, Cerezo-Hernandez A, Gutierrez-Tobal GC et al. Assessment of automated analysis of portable oximetry as a screening test for moderate-to-severe sleep apnea in patients with chronic obstructive pulmonary disease. PloS One. 2017; 12(11):e0188094

37. Andreu AL, Chiner E, Sancho-Chust JN, Pastor E, Llombart M, Gomez-Merino E et al. Effect of an ambulatory diagnostic and treatment programme in patients with sleep apnoea. European Respiratory Journal. 2012; 39(2):305-312

38. Araujo I, Marques F, Andre S, Araujo M, Marques S, Ferreira R et al. Diagnosis of sleep apnea in patients with stable chronic heart failure using a portable sleep test diagnostic device. Sleep & Breathing. 2018; 22(3):749-755

39. Arrazola-Cortes E, Hernandez-Cervantes J, Gonzalez-Perez B, Sauri-Suarez S, Lopez-Hernandez LB, Toledo-Lozano CG et al. Polysomnography-based diagnosis in Mexican adult patients with Obstructive Sleep Apnea Syndrome (OSAS) clinical suspicion. Neuroendocrinology Letters. 2017; 38(6):449-454

40. Arunsurat I, Luengyosluechakul S, Prateephoungrat K, Siripaupradist P, Khemtong S, Jamcharoensup K et al. Simplified berlin questionnaire for screening of high risk for obstructive sleep apnea among Thai male healthcare workers. Journal of UOEH. 2016; 38(3):199-206

41. Assefa SZ, Diaz-Abad M, Korotinsky A, Tom SE, Scharf SM. Comparison of a simple obstructive sleep apnea screening device with standard in-laboratory polysomnography. Sleep & Breathing. 2016; 20(2):537-541

42. Aurora RN, Patil SP, Punjabi NM. Portable sleep monitoring for diagnosing sleep apnea in hospitalized patients with heart failure. Chest. 2018; 154(1):91-98

43. Avincsal MO, Dinc ME, Ulusoy S, Dalgic A, Ozdemir C, Develioglu ON. Modified Mallampati Score improves specificity of STOP-BANG Questionnaire for obstructive sleep apnea. Journal of Craniofacial Surgery. 2017; 28(4):904-908

44. Ayappa I, Norman RG, Seelall V, Rapoport DM. Validation of a self-applied unattended monitor for sleep disordered breathing. Journal of Clinical Sleep Medicine. 2008; 4(1):26-37

45. Ayas NT, Pittman S, MacDonald M, White DP. Assessment of a wrist-worn device in the detection of obstructive sleep apnea. Sleep Medicine. 2003; 4(5):435-442

46. Babaeizadeh S, Zhou SH, Pittman SD, White DP. Electrocardiogram-derived respiration in screening of sleep-disordered breathing. Journal of Electrocardiology. 2011; 44(6):700-706

47. Bagnato MC, Nery LE, Moura SM, Bittencourt LR, Tufik S. Comparison of AutoSet and polysomnography for the detection of apnea-hypopnea events. Brazilian Journal of Medical and Biological Research. 2000; 33(5):515-519

48. BaHammam AS, Al-Aqeel AM, Alhedyani AA, Al-Obaid GI, Al-Owais MM, Olaish AH. The validity and reliability of an arabic version of the STOP-bang questionnaire for identifying obstructive sleep apnea. Open Respiratory Medicine Journal. 2015; 9:22-29

49. BaHammam AS, Sharif M, Gacuan DE, George S. Evaluation of the accuracy of manual and automatic scoring of a single airflow channel in patients with a high probability of obstructive sleep apnea. Medical Science Monitor. 2011; 17(2):MT13-19

50. Ballester E, Solans M, Vila X, Hernandez L, Quinto L, Bolivar I et al. Evaluation of a portable respiratory recording device for detecting apnoeas and hypopnoeas in subjects from a general population. European Respiratory Journal. 2000; 16(1):123-127

51. Baltzan MA, Verschelden P, Al-Jahdali H, Olha AE, Kimoff RJ. Accuracy of oximetry with thermistor (OxiFlow) for diagnosis of obstructive sleep apnea and hypopnea. Sleep. 2000; 23(1):61-69

52. Banhiran W, Chotinaiwattarakul W, Chongkolwatana C, Metheetrairut C. Home-based diagnosis of obstructive sleep apnea by polysomnography type 2: Accuracy, reliability, and feasibility. Sleep & Breathing. 2014; 18(4):817-823

53. Banhiran W, Durongphan A, Saleesing C, Chongkolwatana C. Diagnostic properties of the STOP-Bang and its modified version in screening for obstructive sleep apnea in Thai patients. Journal of the Medical Association of Thailand. 2014; 97(6):644-654

54. Barak-Shinar D, Amos Y, Bogan RK. Sleep disordered breathing analysis in a general population using standard pulse oximeter signals. Sleep & Breathing. 2013; 17(3):1109-1115

55. Barreiro B, Badosa G, Quintana S, Esteban L, Heredia JL. Comparison between automatic and manual analysis in the diagnosis of obstructive sleep apnea-hypopnea syndrome. Archivos de Bronconeumologia. 2003; 39(12):544-548

56. Bausmer U, Gouveris H, Selivanova O, Goepel B, Mann W. Correlation of the Epworth Sleepiness Scale with respiratory sleep parameters in patients with sleep-related breathing disorders and upper airway pathology. European Archives of Oto-Rhino-Laryngology. 2010; 267(10):1645-1648

57. Bauters FA, Loof S, Hertegonne KB, Chirinos JA, De Buyzere ML, Rietzschel ER. Sex-specific sleep apnea screening questionnaires: closing the performance gap in women. Sleep Medicine. 2020; 67:91-98

58. Beattie ZT, Hayes TL, Guilleminault C, Hagen CC. Accurate scoring of the apnea-hypopnea index using a simple non-contact breathing sensor. Journal of Sleep Research. 2013; 22(3):356-362

59. Behar J, Roebuck A, Shahid M, Daly J, Hallack A, Palmius N et al. SleepAp: An automated obstructive sleep apnoea screening application for smartphones. IEEE Journal of Biomedical & Health Informatics. 2015; 19(1):325-331

60. Behar JA, Palmius N, Zacharie S, Chocron A, Penzel T, Bittencourt L et al. Single-channel oximetry monitor versus in-lab polysomnography oximetry analysis: does it make a difference? Physiological Measurement. 2020; 41(4):044007

61. Ben-Israel N, Tarasiuk A, Zigel Y. Obstructive apnea hypopnea index estimation by analysis of nocturnal snoring signals in adults. Sleep. 2012; 35(9):1299-1305C

62. Berry RB, Hill G, Thompson L, McLaurin V. Portable monitoring and autotitration versus polysomnography for the diagnosis and treatment of sleep apnea. Sleep. 2008; 31(10):1423-1431

63. Best MW, Fitzpatrick M, Milev R, Bowie CR, Jokic R. Utility of the Berlin questionnaire for predicting obstructive sleep apnea in individuals with treatment-resistant depression. Sleep & Breathing. 2013; 17(4):1221-1227

64. Bille J, Bille-Hasselstrom C, Petersen CG. Translation and validation of the Stop-Bang Questionnaire for obstructive sleep apnoea into Danish. Danish Medical Journal. 2015; 62(12):A5158

65. Bingol Z, Pihtili A, Kiyan E. Modified STOP-BANG questionnaire to predict obesity hypoventilation syndrome in obese subjects with obstructive sleep apnea. Sleep & Breathing. 2016; 20(2):495-500

66. Bohning N, Zucchini W, Horstmeier O, Bohning W, Fietze I. Sensitivity and specificity of telemedicine-based long-term pulse-oximetry in comparison with cardiorespiratory polygraphy and polysomnography in patients with obstructive sleep apnoea syndrome. Journal of Telemedicine and Telecare. 2011; 17(1):15-19

67. Borsini E, Blanco M, Schonfeld S, Ernst G, Salvado A. Performance of Epworth Sleepiness Scale and tiredness symptom used with simplified diagnostic tests for the identification of sleep apnea. Sleep Science. 2019; 12(4):287-294

68. Borsini E, Ernst G, Salvado A, Bosio M, Chertcoff J, Nogueira F et al. Utility of the STOP-BANG components to identify sleep apnea using home respiratory polygraphy. Sleep & Breathing. 2015; 19(4):1327-1333

69. Boynton G, Vahabzadeh A, Hammoud S, Ruzicka DL, Chervin RD. Validation of the STOP-BANG Questionnaire among patients referred for suspected obstructive sleep apnea. Journal of Sleep Disorders Treatment & Care. 2013; 2(4):23

70. Bradley PA, Mortimore IL, Douglas NJ. Comparison of polysomnography with ResCare Autoset in the diagnosis of the sleep apnoea/hypopnoea syndrome. Thorax. 1995; 50(11):1201-1203

71. Braganza MV, Hanly PJ, Fraser KL, Tsai WH, Pendharkar SR. Predicting CPAP failure in patients with suspected sleep hypoventilation identified on ambulatory testing. Journal of Clinical Sleep Medicine. 2020; http://dx.doi.org/10.5664/jcsm.8616

72. Bravata DM, Sico J, Vaz Fragoso CA, Miech EJ, Matthias MS, Lampert R et al. Diagnosing and treating sleep apnea in patients with acute cerebrovascular disease. Journal of the American Heart Association. 2018; 7(16):e008841

73. Brown DL, Chervin RD, Hegeman G, 3rd, Smith MA, Garcia NM, Morgenstern LB et al. Is technologist review of raw data necessary after home studies for sleep apnea? Journal of Clinical Sleep Medicine. 2014; 10(4):371-375

74. Bsoul M, Minn H, Tamil L. Apnea MedAssist: Real-time sleep apnea monitor using single-lead ECG. IEEE Transactions on Information Technology in Biomedicine. 2011; 15(3):416-427

75. Cai SJ, Chen R, Zhang YL, Xiong KP, Lian YX, Li J et al. Correlation of Epworth Sleepiness Scale with multiple sleep latency test and its diagnostic accuracy in assessing excessive daytime sleepiness in patients with obstructive sleep apnea hypopnea syndrome. Chinese Medical Journal. 2013; 126(17):3245-3250

76. Calleja JM, Esnaola S, Rubio R, Duran J. Comparison of a cardiorespiratory device versus polysomnography for diagnosis of sleep apnoea. European Respiratory Journal. 2002; 20(6):1505-1510

77. Carter GS, Coyle MA, Mendelson WB. Validity of a portable cardio-respiratory system to collect data in the home environment in patients with obstructive sleep apnea. Sleep and Hypnosis. 2004; 6(2):85-92

78. Chai-Coetzer CL, Antic NA, Hamilton GS, McArdle N, Wong K, Yee BJ et al. Physician decision making and clinical outcomes with laboratory polysomnography or limited-channel sleep studies for obstructive sleep apnea: A randomized trial. Annals of Internal Medicine. 2017; 166(5):332-340

79. Chen NH, Chen MC, Li HY, Chen CW, Wang PC. A two-tier screening model using quality-of-life measures and pulse oximetry to screen adults with sleep-disordered breathing. Sleep & Breathing. 2011; 15(3):447-454

80. Chiner E, Signes-Costa J, Arriero JM, Marco J, Fuentes I, Sergado A. Nocturnal oximetry for the diagnosis of the sleep apnoea hypopnoea syndrome: A method to reduce the number of polysomnographies? Thorax. 1999; 54(11):968-971

81. Chiu HY, Chen PY, Chuang LP, Chen NH, Tu YK, Hsieh YJ et al. Diagnostic accuracy of the Berlin questionnaire, STOP-BANG, STOP, and Epworth sleepiness scale in detecting obstructive sleep apnea: A bivariate meta-analysis. Sleep Medicine Reviews. 2017; 36:57-70

82. Christensson E, Franklin KA, Sahlin C, Palm A, Ulfberg J, Eriksson LI et al. Can STOP-Bang and pulse oximetry detect and exclude obstructive sleep apnea? Anesthesia and Analgesia. 2018; 127(3):736-743

83. Chu G, Suthers B, Paech GM, Eyeington L, Gunawardhana L, Palazzi K et al. Feasibility of online haemodiafiltration in sleep apnoea: A randomized crossover study. Blood Purification. 2020; 49(5):604-661

84. Chung F, Liao P, Elsaid H, Islam S, Shapiro CM, Sun Y. Oxygen desaturation index from nocturnal oximetry: A sensitive and specific tool to detect sleep-disordered breathing in surgical patients. Anesthesia and Analgesia. 2012; 114(5):993-1000

85. Chung F, Subramanyam R, Liao P, Sasaki E, Shapiro C, Sun Y. High STOP-Bang score indicates a high probability of obstructive sleep apnoea. British Journal of Anaesthesia. 2012; 108(5):768-775

86. Chung F, Ward B, Ho J, Yuan H, Kayumov L, Shapiro C. Preoperative identification of sleep apnea risk in elective surgical patients, using the Berlin questionnaire. Journal of Clinical Anesthesia. 2007; 19(2):130-134

87. Chung F, Yang Y, Brown R, Liao P. Alternative scoring models of STOP-bang questionnaire improve specificity to detect undiagnosed obstructive sleep apnea. Journal of Clinical Sleep Medicine. 2014; 10(9):951-958

88. Chung F, Yang Y, Liao P. Predictive performance of the STOP-Bang score for identifying obstructive sleep apnea in obese patients. Obesity Surgery. 2013; 23(12):2050-2057

89. Chung F, Yegneswaran B, Liao P, Chung SA, Vairavanathan S, Islam S et al. Validation of the Berlin questionnaire and American Society of Anesthesiologists checklist as screening tools for obstructive sleep apnea in surgical patients. Anesthesiology. 2008; 108(5):822-830

90. Claman D, Murr A, Trotter K. Clinical validation of the Bedbugg in detection of obstructive sleep apnea. Otolaryngology - Head and Neck Surgery. 2001; 125(3):227-230

91. Clark AL, Crabbe S, Aziz A, Reddy P, Greenstone M. Use of a screening tool for detection of sleep-disordered breathing. Journal of Laryngology and Otology. 2009; 123(7):746-749

92. Cooper BG, Veale D, Griffiths CJ, Gibson GJ. Value of nocturnal oxygen saturation as a screening test for sleep apnoea. Thorax. 1991; 46(8):586-588

93. Corral J, Sanchez-Quiroga MA, Carmona-Bernal C, Sanchez-Armengol A, de la Torre AS, Duran-Cantolla J et al. Conventional polysomnography is not necessary for the management of most patients with suspected obstructive sleep apnea. Noninferiority, randomized controlled trial. American Journal of Respiratory and Critical Care Medicine. 2017; 196(9):1181-1190

94. Cowan DC, Allardice G, Macfarlane D, Ramsay D, Ambler H, Banham S et al. Predicting sleep disordered breathing in outpatients with suspected OSA. BMJ Open. 2014; 4(4):e004519

95. Crowley KE, Rajaratnam SM, Shea SA, Epstein LJ, Czeisler CA, Lockley SW et al. Evaluation of a single-channel nasal pressure device to assess obstructive sleep apnea risk in laboratory and home environments. Journal of Clinical Sleep Medicine. 2013; 9(2):109-116

96. Curtis L, Burns A. Unit costs of health and social care 2018. Canterbury. Personal Social Services Research Unit University of Kent, 2018. Available from: https://www.pssru.ac.uk/project-pages/unit-costs/

97. Curtis L, Burns A. Unit costs of health and social care 2019. Canterbury. Personal Social Services Research Unit University of Kent, 2019. Available from: https://www.pssru.ac.uk/project-pages/unit-costs/

98. Damiani MF, Quaranta VN, Falcone VA, Gadaleta F, Maiellari M, Ranieri T et al. The Epworth Sleepiness Scale: conventional self vs physician administration. Chest. 2013; 143(6):1569-1575

99. de Carvalho AA, Amorim FF, Santana LA, de Almeida KJQ, Santana ANC, de Assis Rocha Neves F. STOP-Bang questionnaire should be used in all adults with down Syndrome to screen for moderate to severe obstructive sleep apnea. PloS One. 2020; 15:e0232596

100. de Oliveira ACT, Martinez D, Vasconcelos LFT, Cadaval Goncalves S, do Carmo Lenz M, Costa Fuchs S et al. Diagnosis of obstructive sleep apnea syndrome and its outcomes with home portable monitoring. Chest. 2009; 135(2):330-336

101. de Silva S, Abeyratne UR, Hukins C. A method to screen obstructive sleep apnea using multi-variable non-intrusive measurements. Physiological Measurement. 2011; 32(4):445-465

102. de Vries CEE, de Raaff CAL, Ruys AT, de Vries N, Hilgevoord AAJ, van Wagensveld BA. Validity of a simple sleep monitor for diagnosing OSA in bariatric surgery patients. Surgery for Obesity and Related Diseases. 2018; 14(7):1020-1025

103. de Vries GE, van der Wal HH, Kerstjens HA, van Deursen VM, Stegenga B, van Veldhuisen DJ et al. Validity and predictive value of a portable two-channel sleep-screening tool in the identification of sleep apnea in patients with heart failure. Journal of Cardiac Failure. 2015; 21(10):848-855

104. Deflandre E, Degey S, Brichant JF, Donneau AF, Frognier R, Poirrier R et al. Pre-operative ability of clinical scores to predict obstructive sleep apnea (OSA) severity in susceptible surgical patients. Obesity Surgery. 2017; 27(3):716-729

105. Deflandre E, Piette N, Bonhomme V, Degey S, Cambron L, Poirrier R et al. Comparison of clinical scores in their ability to detect hypoxemic severe OSA patients. PloS One. 2018; 13(5):e0196270

106. del Campo F, Hornero R, Zamarron C, Abasolo DE, Alvarez D. Oxygen saturation regularity analysis in the diagnosis of obstructive sleep apnea. Artificial Intelligence in Medicine. 2006; 37(2):111-118

107. Department of Health. National Schedule of NHS Costs 2018/19 2020. Available from: https://www.england.nhs.uk/national-cost-collection/#ncc1819 Last accessed: 12/06/2020.

108. Dette FG, Graf J, Cassel W, Lloyd-Jones C, Boehm S, Zoremba M et al. Combination of STOP-Bang Score with Mallampati Score fails to improve specificity in the prediction of sleep-disordered breathing. Minerva Anestesiologica. 2016; 82(6):625-634

109. Donovan LM, Fernandes LA, Williams KM, Parsons EC, O'Hearn DJ, He K et al. Agreement of sleep specialists with registered nurses' sleep study orders in supervised clinical practice. Journal of Clinical Sleep Medicine. 2020; 16(2):279-283

110. Doshi V, Walia R, Jones K, Aston CE, Awab A. STOP-BANG questionnaire as a screening tool for diagnosis of obstructive sleep apnea by unattended portable monitoring sleep study. Springerplus. 2015; 4:795

111. Douglas NJ, Thomas S, Jan MA. Clinical value of polysomnography. Lancet. 1992; 339(8789):347-350

112. Duarte RL, Magalhaes-da-Silveira FJ, Oliveira ESTS, Silva JA, Mello FC, Gozal D. Obstructive sleep apnea screening with a 4-item instrument, named goal questionnaire: Development, validation and comparative study with No-Apnea, STOP-Bang, and NoSAS. Nature & Science of Sleep. 2020; 12:57-67

113. Duarte RLM, Fonseca LBM, Magalhaes-da-Silveira FJ, Silveira EAD, Rabahi MF. Validation of the STOP-Bang questionnaire as a means of screening for obstructive sleep apnea in adults in Brazil. Jornal Brasileiro de Pneumologia : Publicacao Oficial da Sociedade Brasileira de Pneumologia e Tisilogia 2017; 43(6):456-463

114. Dzieciolowska-Baran E, Gawlikowska-Sroka A, Szczurowski J. Diagnosis of sleep-disordered breathing in the home environment. 'In:' Pokorski M, editor. Medical Research and Development Advances in Experimental Medicine and Biology, vol 1271: Springer Cham. 2020.

115. Ebben MR, Krieger AC. Diagnostic accuracy of a mathematical model to predict apnea-hypopnea index using nighttime pulse oximetry. Journal of Biomedical Optics. 2016; 21(3):35006

116. Ehsan Z, He S, Huang G, Hossain MM, Simakajornboon N. Can overnight portable pulse oximetry be used to stratify obstructive sleep apnea risk in infants? A correlation analysis. Pediatric Pulmonology. 2020; 55(8):2082-2088

117. El Shayeb M, Topfer LA, Stafinski T, Pawluk L, Menon D. Diagnostic accuracy of level 3 portable sleep tests versus level 1 polysomnography for sleep-disordered breathing: A systematic review and meta-analysis. CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne. 2014; 186(1):E25-51

118. Ellingsen I, Fondenes O, Overland B, Holmedahl NH. The severity of sleep hypoventilation in stable chronic obstructive pulmonary disease. Sleep and Breathing. 2020; http://dx.doi.org/10.1007/s11325-020-02097-y

119. Emsellem HA, Corson WA, Rappaport BA, Hackett S, Smith LG, Hausfeld JN. Verification of sleep apnea using a portable sleep apnea screening device. Southern Medical Journal. 1990; 83(7):748-752

120. Epstein LJ, Dorlac GR. Cost-effectiveness analysis of nocturnal oximetry as a method of screening for sleep apnea-hypopnea syndrome. Chest. 1998; 113(1):97-103

121. Eris Gulbay B, Acican T, Ciftci F, Erdemir Isik M, Onen ZP. Comparison of polysomnography variables in obstructive sleep apnea patients with or without excessive daytime sleepiness. Turkiye Klinikleri Journal of Medical Sciences. 2014; 34(1):87-92

122. Erman MK, Stewart D, Einhorn D, Gordon N, Casal E. Validation of the ApneaLink for the screening of sleep apnea: A novel and simple single-channel recording device. Journal of Clinical Sleep Medicine. 2007; 3(4):387-392

123. Ernst G, Bosio M, Salvado A, Nogueira F, Nigro C, Borsini E. Comparative study between sequential automatic and manual home respiratory polygraphy scoring using a three-channel device: Impact of the manual editing of events to identify severe Obstructive Sleep Apnea. Sleep Disorders Print. 2015; 2015:314534

124. Esnaola S, Duran J, Infante-Rivard C, Rubio R, Fernandez A. Diagnostic accuracy of a portable recording device (MESAM IV) in suspected obstructive sleep apnoea. European Respiratory Journal. 1996; 9(12):2597-2605

125. Fabius TM, Benistant JR, Bekkedam L, van der Palen J, de Jongh FHC, Eijsvogel MMM. Validation of the oxygen desaturation index in the diagnostic workup of obstructive sleep apnea. Sleep & Breathing. 2019; 23(1):57-63

126. Faria AC, da Costa CH, Rufino R. Sleep Apnea Clinical Score, Berlin Questionnaire, or Epworth Sleepiness Scale: Which is the best obstructive sleep apnea predictor in patients with COPD? International Journal of General Medicine. 2015; 8:275-281

127. Farney RJ, Walker LE, Jensen RL, Walker JM. Ear oximetry to detect apnea and differentiate rapid eye movement (REM) and non-REM (NREM) sleep. Screening for the sleep apnea syndrome. Chest. 1986; 89(4):533-539

128. Fasbender P, Haddad A, Burgener S, Peters J. Validation of a photoplethysmography device for detection of obstructive sleep apnea in the perioperative setting. Journal of Clinical Monitoring and Computing. 2019; 33(2):341-345

129. Fawale MB, Ibigbami O, Ismail I, Mustapha AF, Komolafe MA, Olamoyegun MA et al. Risk of obstructive sleep apnea, excessive daytime sleepiness and depressive symptoms in a Nigerian elderly population. Sleep Science. 2016; 9(2):106-111

130. Felfeli T, Alon R, Al Adel F, Shapiro CM, Mandelcorn ED, Brent MH. Screening for obstructive sleep apnea amongst patients with retinal vein occlusion. Canadian Journal of Ophthalmology. 2020; 55(4):310-316

131. Firat H, Yuceege M, Demir A, Ardic S. Comparison of four established questionnaires to identify highway bus drivers at risk for obstructive sleep apnea in Turkey. Sleep and Biological Rhythms. 2012; 10(3):231-236

132. Fletcher EC, Stich J, Yang KL. Unattended home diagnosis and treatment of obstructive sleep apnea without polysomnography. Archives of Family Medicine. 2000; 9(2):168-174

133. Forni Ogna V, Ogna A, Pruijm M, Bassi I, Zuercher E, Halabi G et al. Prevalence and diagnostic approach to sleep apnea in hemodialysis patients: A population study. BioMed Research International. 2015; 2015:103686

134. Frangopoulos F, Nicolaou I, Zannetos S, Economou NT, Adamide T, Georgiou A et al. Estimating obstructive sleep apnea in Cyprus: a randomised, stratified epidemiological study using STOP-Bang sleep apnea questionnaire. Sleep Medicine. 2019; 61:37-43

135. Fry JM, DiPhillipo MA, Curran K, Goldberg R, Baran AS. Full polysomnography in the home. Sleep. 1998; 21(6):635-642

136. Fuller JM, Wong KK, Grunstein R, Krass I, Patel J, Saini B. A comparison of screening methods for sleep disorders in Australian community pharmacies: A randomized controlled trial. PloS One. 2014; 9(6):e101003

137. Gabryelska A, Mokros L, Kardas G, Panek M, Riha R, Bialasiewicz P. The predictive value of BOAH scale for screening obstructive sleep apnea in patients at a sleep clinic in Scotland. Sleep and Breathing. 2020; https://doi.org/10.1007/s11325-020-02114-0

138. Gagnadoux F, Pelletier-Fleury N, Philippe C, Rakotonanahary D, Fleury B. Home unattended vs hospital telemonitored polysomnography in suspected obstructive sleep apnea syndrome: A randomized crossover trial. Chest. 2002; 121(3):753-758

139. Gantner D, Ge JY, Li LH, Antic N, Windler S, Wong K et al. Diagnostic accuracy of a questionnaire and simple home monitoring device in detecting obstructive sleep

apnoea in a Chinese population at high cardiovascular risk. Respirology. 2010; 15(6):952-960

140. Garg N, Rolle AJ, Lee TA, Prasad B. Home-based diagnosis of obstructive sleep apnea in an urban population. Journal of Clinical Sleep Medicine. 2014; 10(8):879-885

141. Gasa M, Salord N, Fortuna AM, Mayos M, Embid C, Vilarrasa N et al. Optimizing screening of severe obstructive sleep apnea in patients undergoing bariatric surgery. Surgery for Obesity and Related Diseases. 2013; 9(4):539-546

142. Geessinck FAJ, Pleijhuis RG, Mentink RJ, van der Palen J, Koffijberg H. Cost-effectiveness analysis of the DiagnOSAS Screening Tool compared with polysomnography diagnosis in Dutch primary care. Journal of Clinical Sleep Medicine. 2018; 14(6):1005-1015

143. Gergely V, Pallos H, Mashima K, Miyazaki S, Tanaka T, Okawa M et al. Evaluation of the usefulness of the SleepStrip for screening obstructive sleep apnea-hypopnea syndrome in Japan. Sleep and Biological Rhythms. 2009; 7(1):43-51

144. Giampa SQC, Pedrosa RP, Gonzaga CC, Bertolami A, Amodeo C, Furlan SF et al. Performance of NoSAS score versus Berlin questionnaire for screening obstructive sleep apnoea in patients with resistant hypertension. Journal of Human Hypertension. 2018; 32(7):518-523

145. Gjevre JA, Taylor-Gjevre RM, Skomro R, Reid J, Fenton M, Cotton D. Comparison of polysomnographic and portable home monitoring assessments of obstructive sleep apnea in Saskatchewan women. Canadian Respiratory Journal. 2011; 18(5):271-274

146. Glantz H, Thunstrom E, Herlitz J, Cederin B, Nasic S, Ejdeback J et al. Occurrence and predictors of obstructive sleep apnea in a revascularized coronary artery disease cohort. Annals of the American Thoracic Society. 2013; 10(4):350-356

147. Glazer SA, Erickson AL, Crosby RD, Kieda J, Zawisza A, Deitel M. The evaluation of screening questionnaires for obstructive sleep apnea to identify high-risk obese patients undergoing bariatric surgery. Obesity Surgery. 2018; 28(11):3544-3552

148. Goldstein CA, Karnib H, Williams K, Virk Z, Shamim-Uzzaman A. The utility of home sleep apnea tests in patients with low versus high pre-test probability for moderate to severe OSA. Sleep & Breathing. 2018; 22(3):641-651

149. Golpe R, Jimenez A, Carpizo R. Home sleep studies in the assessment of sleep apnea/hypopnea syndrome. Chest. 2002; 122(4):1156-1161

150. Golpe R, Jimenez A, Carpizo R, Cifrian JM. Utility of home oximetry as a screening test for patients with moderate to severe symptoms of obstructive sleep apnea. Sleep. 1999; 22(7):932-937

151. Goodrich S, Orr WC. An investigation of the validity of the Lifeshirt in comparison to standard polysomnography in the detection of obstructive sleep apnea. Sleep Medicine. 2009; 10(1):118-122

152. Graco M, Schembri R, Cross S, Thiyagarajan C, Shafazand S, Ayas NT et al. Diagnostic accuracy of a two-stage model for detecting obstructive sleep apnoea in chronic tetraplegia. Thorax. 2018; 73(9):864-871

153. Gros P, Mery VP, Lafontaine AL, Robinson A, Benedetti A, Kimoff RJ et al. Diagnosis of obstructive sleep apnea in parkinson's disease patients: Is unattended portable monitoring a suitable tool? Parkinsons Disease. 2015; 2015:258418

154. Grover M, Mookadam M, Chang YH, Parish JM. Obstructive sleep apnea: A better Dx model for primary care. Journal of Family Practice. 2018; 67(11):E1-E7

155. Grover SS, Pittman SD. Automated detection of sleep disordered breathing using a nasal pressure monitoring device. Sleep & Breathing. 2008; 12(4):339-345

156. Gu W, Leung L, Kwok KC, Wu IC, Folz RJ, Chiang AA. Belun Ring Platform: a novel home sleep apnea testing system for assessment of obstructive sleep apnea. Journal of Clinical Sleep Medicine. 2020; http://dx.doi.org/10.5664/jcsm.8592

157. Gugger M. Comparison of ResMed AutoSet (version 3.03) with polysomnography in the diagnosis of the sleep apnoea/hypopnoea syndrome. European Respiratory Journal. 1997; 10(3):587-591

158. Guimaraes C, Martins MV, Vaz Rodrigues L, Teixeira F, Moutinho Dos Santos J. Epworth Sleepiness Scale in obstructive sleep apnea syndrome--an underestimated subjective scale. Revista Portuguesa de Pneumologia. 2012; 18(6):267-271

159. Gumb T, Twumasi A, Alimokhtari S, Perez A, Black K, Rapoport DM et al. Comparison of two home sleep testing devices with different strategies for diagnosis of OSA. Sleep & Breathing. 2018; 22(1):139-147

160. Gunduz C, Basoglu OK, Tasbakan MS. Prevalence of overlap syndrome in chronic obstructive pulmonary disease patients without sleep apnea symptoms. Clinical Respiratory Journal. 2018; 12(1):105-112

161. Gupta R, Ali R, Dhyani M, Das S, Pundir A. Hindi translation of Berlin questionnaire and its validation as a screening instrument for obstructive sleep apnea. Journal of Neurosciences in Rural Practice. 2016; 7(2):244-249

162. Gyulay S, Olson LG, Hensley MJ, King MT, Allen KM, Saunders NA. A comparison of clinical assessment and home oximetry in the diagnosis of obstructive sleep apnea. American Review of Respiratory Disease. 1993; 147(1):50-53

163. Ha SC, Lee DL, Abdullah VJ, van Hasselt CA. Evaluation and validation of four translated Chinese questionnaires for obstructive sleep apnea patients in Hong Kong. Sleep & Breathing. 2014; 18(4):715-721

164. Hang LW, Wang HL, Chen JH, Hsu JC, Lin HH, Chung WS et al. Validation of overnight oximetry to diagnose patients with moderate to severe obstructive sleep apnea. BMC Pulmonary Medicine. 2015; 15:24

165. Hara H, Murakami N, Miyauchi Y, Yamashita H. Acoustic analysis of snoring sounds by a multidimensional voice program. Laryngoscope. 2006; 116(3):379-381

166. Hashizaki M, Nakajima H, Tsutsumi M, Shiga T, Chiba S, Yagi T et al. Accuracy validation of sleep measurements by a contactless biomotion sensor on subjects with suspected sleep apnea. Sleep and Biological Rhythms. 2014; 12(2):106-115

167. Heneghan C, de Chazal P, Ryan S, Chua CP, Doherty L, Boyle P et al. Electrocardiogram recording as a screening tool for sleep disordered breathing. Journal of Clinical Sleep Medicine. 2008; 4(3):223-228

168. Herer B, Fuhrman C, Roig C, Housset B. Prediction of obstructive sleep apnea by OxiFlow in overweight patients. Sleep Medicine. 2002; 3(5):417-422

169. Hernandez-Bendezu MDC, Arias-Pena MY, Torres-Fraga MG, Carrillo-Alduenda JL. Quality of an ambulatory monitoring technique for diagnosing obstructive sleep apnea under conditions of limited resources. Sleep Science. 2018; 11(4):269-273

170. Hesselbacher S, Subramanian S, Allen J, Surani S, Surani S. Body mass index, gender, and ethnic variations alter the clinical implications of the epworth sleepiness scale in patients with suspected obstructive sleep apnea. Open Respiratory Medicine Journal. 2012; 6:20-27

171. Hilmisson H, Lange N, Duntley SP. Sleep apnea detection: Accuracy of using automated ECG analysis compared to manually scored polysomnography (apnea hypopnea index) Sleep & Breathing. 2019; 23(1):125-133

172. Holmedahl NH, Fjeldstad OM, Engan H, Saxvig IW, Gronli J. Validation of peripheral arterial tonometry as tool for sleep assessment in chronic obstructive pulmonary disease. Scientific Reports. 2019; 9(1):19392

173. Hong C, Chen R, Qing S, Kuang A, Yang H, Su X et al. Validation of the NoSAS Score for the screening of sleep-disordered breathing: A hospital-based retrospective study in China. Journal of Clinical Sleep Medicine. 2018; 14(2):191-197

174. Horvath CM, Jossen J, Kroll D, Nett PC, Baty F, Brill AK et al. Prevalence and prediction of obstructive sleep apnea prior to bariatric surgery-gender-specific performance of four sleep questionnaires. Obesity Surgery. 2018; 28(9):2720-2726

175. Hui DS, Ng SS, To KW, Ko FW, Ngai J, Chan KK et al. A randomized controlled trial of an ambulatory approach versus the hospital-based approach in managing suspected obstructive sleep apnea syndrome. Scientific Reports. 2017; 8:45901

176. Hussain SF, Fleetham JA. Overnight home oximetry: Can it identify patients with obstructive sleep apnea-hypopnea who have minimal daytime sleepiness? Respiratory Medicine. 2003; 97(5):537-540

177. Iber C, Redline S, Kaplan Gilpin AM, Quan SF, Zhang L, Gottlieb DJ et al. Polysomnography performed in the unattended home versus the attended laboratory setting--Sleep Heart Health Study methodology. Sleep. 2004; 27(3):536-540

178. Ibrahim AS, Almohammed AA, Allangawi MH, HA AS, Mobayed HS, Pannerselvam B et al. Predictors of obstructive sleep apnea in snorers. Annals of Saudi Medicine. 2007; 27(6):421-426

179. Ioachimescu OC, Allam JS, Samarghandi A, Anand N, Fields BG, Dholakia SA et al. Performance of peripheral arterial tonometry based testing for the diagnosis of obstructive sleep apnea in a large sleep clinic cohort. Journal of Clinical Sleep Medicine. 2020; http://dx.doi.org/10.5664/jcsm.8620

180. Isaac BTJ, Clarke SE, Islam MS, Samuel JT. Screening for obstructive sleep apnoea using the STOPBANG questionnaire and the Epworth sleepiness score in patients admitted on the unselected acute medical take in a UK hospital. Clinical Medicine. 2017; 17(6):499-503

181. Jen R, Orr JE, Li Y, DeYoung P, Smales E, Malhotra A et al. Accuracy of WatchPAT for the diagnosis of obstructive sleep apnea in patients with chronic obstructive pulmonary disease. COPD: Journal of Chronic Obstructive Pulmonary Disease. 2020; 17(1):34-39

182. Jobin V, Mayer P, Bellemare F. Predictive value of automated oxygen saturation analysis for the diagnosis and treatment of obstructive sleep apnoea in a home-based setting. Thorax. 2007; 62(5):422-427

183. Jurado Gamez B, Redel Montero J, Munoz Cabrera L, Fernandez Marin MC, Munoz Gomariz E, Martin Perez MA et al. Cost-effectiveness and degree of satisfaction with

home sleep monitoring in patients with symptoms of sleep apnea. Archivos de Bronconeumologia. 2007; 43(11):605-610

184. Kahal H, Tahrani AA, Kyrou I, Dimitriadis GK, Kimani PK, Barber TM et al. The relationship between obstructive sleep apnoea and quality of life in women with polycystic ovary syndrome: a cross-sectional study. Therapeutic Advances in Endocrinology and Metabolism. 2020; 11:1-12

185. Kaminska M, Jobin V, Mayer P, Amyot R, Perraton-Brillon M, Bellemare F. The Epworth Sleepiness Scale: Self-administration versus administration by the physician, and validation of a French version. Canadian Respiratory Journal. 2010; 17(2):e27-34

186. Karakoc O, Akcam T, Genc H, Yetkin S, Piskin B, Gerek M. Use of the Berlin Questionnaire to screen at-risk patients for obstructive sleep apnea. B-ENT. 2014; 10(1):21-25

187. Karaloglu F, Kemaloglu YK, Yilmaz M, Ulukavak Ciftci T, Ciftci B, Bakkal FK. Comparison of full-night and ambulatory polysomnography with ApneaGraph in the subjects with obstructive sleep apnea syndrome. European Archives of Oto-Rhino-Laryngology. 2017; 274(1):189-195

188. Katzan IL, Thompson NR, Uchino K, Foldvary-Schaefer N. A screening tool for obstructive sleep apnea in cerebrovascular patients. Sleep Medicine. 2016; 21:70-76

189. Khandoker AH, Gubbi J, Palaniswami M. Automated scoring of obstructive sleep apnea and hypopnea events using short-term electrocardiogram recordings. IEEE Transactions on Information Technology in Biomedicine. 2009; 13(6):1057-1067

190. Kicinski P, Przybylska-Kuc SM, Tatara K, Dybala A, Zakrzewski M, Myslinski W et al. Reliability of the Epworth Sleepiness Scale and the Berlin Questionnaire for screening obstructive sleep apnea syndrome in the context of the examination of candidates for drivers. Medycyna Pracy. 2016; 67(6):721-728

191. Kiely JL, Delahunty C, Matthews S, McNicholas WT. Comparison of a limited computerized diagnostic system (ResCare Autoset) with polysomnography in the diagnosis of obstructive sleep apnoea syndrome. European Respiratory Journal. 1996; 9(11):2360-2364

192. Kim B, Lee EM, Chung YS, Kim WS, Lee SA. The utility of three screening questionnaires for obstructive sleep apnea in a sleep clinic setting. Yonsei Medical Journal. 2015; 56(3):684-690

193. Kim RD, Kapur VK, Redline-Bruch J, Rueschman M, Auckley DH, Benca RM et al. An economic evaluation of home versus laboratory-based diagnosis of obstructive sleep apnea. Sleep. 2015; 38(7):1027-1037

194. Korvel-Hanquist A, Andersen IG, Lauritzen SEK, Dahlgaard S, Moritz J. Validation of the Danish STOP-Bang obstructive sleep apnoea questionnaire in a public sleep clinic. Danish Medical Journal. 2018; 65(1):1-5

195. Kristiansen S, Traaen GM, Overland B, Plagemann T, Gullestad L, Akre H et al. Comparing manual and automatic scoring of sleep monitoring data from portable polygraphy. Journal of Sleep Research. 2020; http://dx.doi.org/10.1111/jsr.13036

196. Kukwa W, Migacz E, Lis T, Ishman SL. The effect of in-lab polysomnography and home sleep polygraphy on sleep position. Sleep & Breathing. 2020; http://dx.doi.org/10.1007/s11325-020-02099-w

197. Kum RO, Kundi FCS, Baklaci D, Kum NY, Guler I, Yilmaz YF et al. Predicting severe sleep apnea in patients with complaints: Pulse oximetry and body mass index. Turk Otorinolarengoloji Arsivi. 2018; 56(3):149-154

198. Kum RO, Ozcan M, Yurtsever Kum N, Yilmaz YF, Gungor V, Unal A. A new suggestion for the Epworth Sleepiness Scale in obstructive sleep apnea. European Archives of Oto-Rhino-Laryngology. 2015; 272(1):247-252

199. Kuna ST, Gurubhagavatula I, Maislin G, Hin S, Hartwig KC, McCloskey S et al. Noninferiority of functional outcome in ambulatory management of obstructive sleep apnea. American Journal of Respiratory and Critical Care Medicine. 2011; 183(9):1238-1244

200. Lachapelle P, Cascon J, Pamidi S, Kimoff RJ. Accuracy of portable devices in sleep apnea using oximetry-derived heart rate increases as a surrogate arousal marker. Sleep & Breathing. 2019; 23(2):483-492

201. Lado MJ, Vila XA, Rodriguez-Linares L, Mendez AJ, Olivieri DN, Felix P. Detecting sleep apnea by heart rate variability analysis: Assessing the validity of databases and algorithms. Journal of Medical Systems. 2011; 35(4):473-481

202. Lajoie AC, Series F, Bernard S, Bernard E, Santaolalla CJE, Abad Fernandez A et al. Reliability of home nocturnal oximetry in the diagnosis of overlap syndrome in COPD. Respiration. 2020; 99(2):132-139

203. Lam DC, Lui MM, Lam JC, Ong LH, Lam KS, Ip MS. Prevalence and recognition of obstructive sleep apnea in Chinese patients with type 2 diabetes mellitus. Chest. 2010; 138(5):1101-1107

204. Laohasiriwong S, Johnston N, Woodson BT. Extra-esophageal reflux, NOSE score, and sleep quality in an adult clinic population. Laryngoscope. 2013; 123(12):3233-3238

205. Laporta R, Anandam A, El-Solh AA. Screening for obstructive sleep apnea in veterans with ischemic heart disease using a computer-based clinical decision-support system. Clinical Research in Cardiology. 2012; 101(9):737-744

206. Laranjeira CM, Barbosa ERF, Rabahi MF. Is subjective sleep evaluation a good predictor for obstructive sleep apnea? Clinics (Sao Paulo, Brazil). 2018; 73:e355

207. Lauritzen E, Korvel-Hanquist A, Homoe P. The Danish translation and validation of the Berlin Questionnaire for sleep apnoea. Danish Medical Journal. 2018; 65(9):A5502

208. Lazaro J, Claveria P, Cabrejas C, Fernando J, Segura S, Marin JM. Sensitivity of a sequential model based on a questionnaire (STOP-Bang vs Dixon) and nocturnal pulse oximetry for screening obstructive sleep apnea in patients with morbid obesity candidates for bariatric surgery. Endocrinologia Diabetes y Nutricion. 2020; 67(8):509-516

209. Le TQ, Bukkapatnam ST. Nonlinear dynamics forecasting of obstructive sleep apnea onsets. PloS One. 2016; 11(11):e0164406

210. Leclerc G, Lacasse Y, Page D, Series F. Do obstructive sleep apnea syndrome patients underestimate their daytime symptoms before continuous positive airway pressure treatment? Canadian Respiratory Journal. 2014; 21(4):216-220

211. Lee CH, Won TB, Cha W, Yoon IY, Chung S, Kim JW. Obstructive site localization using multisensor manometry versus the Friedman staging system in obstructive sleep apnea. European Archives of Oto-Rhino-Laryngology. 2008; 265(2):171-177

212. Lee H, Park J, Kim H, Lee KJ. New rule-based algorithm for real-time detecting sleep apnea and hypopnea events using a nasal pressure signal. Journal of Medical Systems. 2016; 40(12):282

213. Lee HK, Kim H, Lee KJ. Nasal pressure recordings for automatic snoring detection. Medical and Biological Engineering and Computing. 2015; 53(11):1103-1111

214. Lee HK, Lee J, Kim H, Ha JY, Lee KJ. Snoring detection using a piezo snoring sensor based on hidden Markov models. Physiological Measurement. 2013; 34(5):N41-49

215. Lee IS, Bardwell W, Ancoli-Israel S, Natarajan L, Loredo JS, Dimsdale JE. The Relationship between psychomotor vigilance performance and quality of life in obstructive sleep apnea. Journal of Clinical Sleep Medicine. 2011; 7(3):254-260

216. Lee LA, Lo YL, Yu JF, Lee GS, Ni YL, Chen NH et al. Snoring sounds predict obstruction sites and surgical response in patients with obstructive sleep apnea hypopnea syndrome. Scientific Reports. 2016; 6:30629

217. Lee SA, Han SH, Ryu HU. Anxiety and its relationship to quality of life independent of depression in patients with obstructive sleep apnea. Journal of Psychosomatic Research. 2015; 79(1):32-36

218. Lee SA, Paek JH, Han SH. Sleep hygiene and its association with daytime sleepiness, depressive symptoms, and quality of life in patients with mild obstructive sleep apnea. Journal of the Neurological Sciences. 2015; 359(1-2):445-449

219. Lee SJ, Kang HW, Lee LH. The relationship between the Epworth Sleepiness Scale and polysomnographic parameters in obstructive sleep apnea patients. European Archives of Oto-Rhino-Laryngology. 2012; 269(4):1143-1147

220. Leitzen KP, Brietzke SE, Lindsay RW. Correlation between nasal anatomy and objective obstructive sleep apnea severity. Otolaryngology - Head and Neck Surgery. 2014; 150(2):325-331

221. Lentini S, Manka R, Scholtyssek S, Stoffel-Wagner B, Luderitz B, Tasci S. Creatine phosphokinase elevation in obstructive sleep apnea syndrome: An unknown association? Chest. 2006; 129(1):88-94

222. Leppanen T, Sarkka M, Kulkas A, Muraja-Murro A, Kupari S, Anttonen M et al. RemLogic plug-in enables clinical application of apnea-hypopnea index adjusted for severity of individual obstruction events. Journal of Medical Engineering and Technology. 2016; 40(3):119-126

223. Levartovsky A, Dafna E, Zigel Y, Tarasiuk A. Breathing and snoring sound characteristics during sleep in adults. Journal of Clinical Sleep Medicine. 2016; 12(3):375-384

224. Levendowski D, Steward D, Woodson BT, Olmstead R, Popovic D, Westbrook P. The impact of obstructive sleep apnea variability measured in-lab versus in-home on sample size calculations. International Archives of Medicine. 2009; 2:2

225. Levendowski DJ, Oksenberg A, Vicini C, Penzel T, Levi M, Westbrook PR. A systematic comparison of factors that could impact treatment recommendations for patients with Positional Obstructive Sleep Apnea (POSA). Sleep Medicine. 2018; 50:145-151

226. Levendowski DJ, Veljkovic B, Seagraves S, Westbrook PR. Capability of a neck worn device to measure sleep/wake, airway position, and differentiate benign snoring from obstructive sleep apnea. Journal of Clinical Monitoring and Computing. 2015; 29(1):53-64

227. Levy P, Pepin JL, Deschaux-Blanc C, Paramelle B, Brambilla C. Accuracy of oximetry for detection of respiratory disturbances in sleep apnea syndrome. Chest. 1996; 109(2):395-399

228. Li K, Pan W, Li Y, Jiang Q, Liu G. A method to detect sleep apnea based on deep neural network and hidden Markov model using single-lead ECG signal. Neurocomputing. 2018; 294:94-101

229. Li Y, Gao H, Ma Y. Evaluation of pulse oximeter derived photoplethysmographic signals for obstructive sleep apnea diagnosis. Medicine. 2017; 96(18):e6755

230. Li Y, Zhang J, Lei F, Liu H, Li Z, Tang X. Self-evaluated and close relative-evaluated Epworth Sleepiness Scale vs. multiple sleep latency test in patients with obstructive sleep apnea. Journal of Clinical Sleep Medicine. 2014; 10(2):171-176

231. Liam CK. A portal recording system for the assessment of patients with sleep apnoea syndrome. Medical Journal of Malaysia. 1996; 51(1):82-88

232. Liesching TN, Carlisle C, Marte A, Bonitati A, Millman RP. Evaluation of the accuracy of SNAP technology sleep sonography in detecting obstructive sleep apnea in adults compared to standard polysomnography. Chest. 2004; 125(3):886-891

233. Lim JS, Lee JW, Han C, Kwon JW. Correlation of soft palate length with velum obstruction and severity of obstructive sleep apnea syndrome. Auris, Nasus, Larynx. 2018; 45(3):499-503

234. Lim LL, Tham KW, Fook-Chong SM. Obstructive sleep apnoea in Singapore: Polysomnography data from a tertiary sleep disorders unit. Annals of the Academy of Medicine, Singapore. 2008; 37(8):629-636

235. Lin CL, Yeh C, Yen CW, Hsu WH, Hang LW. Comparison of the indices of oxyhemoglobin saturation by pulse oximetry in obstructive sleep apnea hypopnea syndrome. Chest. 2009; 135(1):86-93

236. Ling IT, James AL, Hillman DR. Interrelationships between body mass, oxygen desaturation, and apnea-hypopnea indices in a sleep clinic population. Sleep. 2012; 35(1):89-96

237. Linz D, Kadhim K, Brooks AG, Elliott AD, Hendriks JML, Lau DH et al. Diagnostic accuracy of overnight oximetry for the diagnosis of sleep-disordered breathing in atrial fibrillation patients. International Journal of Cardiology. 2018; 272:155-161

238. Lipatov K, Hayek A, Ghamande S, Boethel C, Chen W, Jones S. Predictors of obstructive sleep apnea on a home sleep apnea test after a negative attended polysomnography. Journal of Clinical Sleep Medicine. 2018; 14(11):1889-1894

239. Littner MR. Portable monitoring in the diagnosis of the obstructive sleep apnea syndrome. Seminars in Respiratory and Critical Care Medicine. 2005; 26(1):56-67

240. Liu D, Yang X, Wang G, Ma J, Liu Y, Peng CK et al. HHT based cardiopulmonary coupling analysis for sleep apnea detection. Sleep Medicine. 2012; 13(5):503-509

241. Liu WT, Wu HT, Juang JN, Wisniewski A, Lee HC, Wu D et al. Prediction of the severity of obstructive sleep apnea by anthropometric features via support vector machine. PloS One. 2017; 12(5):e0176991

242. Lloberes P, Montserrat JM, Ascaso A, Parra O, Granados A, Alonso P et al. Comparison of partially attended night time respiratory recordings and full polysomnography in patients with suspected sleep apnoea/hypopnoea syndrome. Thorax. 1996; 51(10):1043-1047

243. Lloberes P, Sampol G, Levy G, Aristizabal D, Sagales T, De la Calzada M et al. Influence of setting on unattended respiratory monitoring in the sleep apnoea/hypopnoea syndrome. European Respiratory Journal. 2001; 18(3):530-534

244. Lopes C, Esteves AM, Bittencourt LR, Tufik S, Mello MT. Relationship between the quality of life and the severity of obstructive sleep apnea syndrome. Brazilian Journal of Medical and Biological Research. 2008; 41(10):908-913

245. Lopez-Acevedo MN, Torres-Palacios A, Elena Ocasio-Tascon M, Campos-Santiago Z, Rodriguez-Cintron W. Overlap syndrome: An indication for sleep studies? Sleep & Breathing. 2009; 13(4):409-413

246. Lopez-Acevedo MN, Torres-Palacios A, Elena Ocasio-Tascon M, Campos-Santiago Z, Rodriguez-Cintron W. Overlap syndrome: An indication for sleep studies? : A pilot study. Sleep & Breathing. 2009; 13(4):409-413

247. Lu H, Fu C, Li W, Jiang H, Wu X, Li S. Screening for obstructive sleep apnea syndrome in asthma patients: A prospective study based on Berlin and STOP-Bang questionnaires. Journal of Thoracic Disease. 2017; 9(7):1945-1958

248. Lucey BP, McLeland JS, Toedebusch CD, Boyd J, Morris JC, Landsness EC et al. Comparison of a single-channel EEG sleep study to polysomnography. Journal of Sleep Research. 2016; 25(6):625-635

249. Luo J, Huang R, Zhong X, Xiao Y, Zhou J. STOP-Bang questionnaire is superior to Epworth sleepiness scales, Berlin questionnaire, and STOP questionnaire in screening obstructive sleep apnea hypopnea syndrome patients. Chinese Medical Journal. 2014; 127(17):3065-3070

250. Luo J, Huang R, Zhong X, Xiao Y, Zhou J. Value of STOP-Bang questionnaire in screening patients with obstructive sleep apnea hypopnea syndrome in sleep disordered breathing clinic. Chinese Medical Journal. 2014; 127(10):1843-1848

251. Luo M, Zheng HY, Zhang Y, Feng Y, Li DQ, Li XL et al. A nomogram for predicting the likelihood of obstructive sleep apnea to reduce the unnecessary polysomnography examinations. Chinese Medical Journal. 2015; 128(16):2134-2140

252. Macavei VM, Spurling KJ, Loft J, Makker HK. Diagnostic predictors of obesity-hypoventilation syndrome in patients suspected of having sleep disordered breathing. Journal of Clinical Sleep Medicine. 2013; 9(9):879-884

253. MacGregor CA, Karimi D, Azarbarzin A, Moussavi Z. Statistical analysis of tracheal breath sounds during wakefulness for screening obstructive sleep apnea. Conference Proceedings: Annual International Conference of the IEEE Engineering in Medicine & Biology Society. 2013; 2013:4549-4552

254. MacGregor CA, Moussavi Z. A novel expert classifier approach to pre-screening obstructive sleep apnea during wakefulness. Conference Proceedings: Annual International Conference of the IEEE Engineering in Medicine & Biology Society. 2014; 2014:4236-4239

255. Mador MJ, Kufel TJ, Magalang UJ, Rajesh SK, Watwe V, Grant BJ. Prevalence of positional sleep apnea in patients undergoing polysomnography. Chest. 2005; 128(4):2130-2137

256. Maeder MT, Strobel W, Christ M, Todd J, Estis J, Wildi K et al. Comprehensive biomarker profiling in patients with obstructive sleep apnea. Clinical Biochemistry. 2015; 48(4-5):340-346

257. Maestri R, La Rovere MT, Robbi E, Pinna GD. Night-to-night repeatability of measurements of nocturnal breathing disorders in clinically stable chronic heart failure patients. Sleep & Breathing. 2011; 15(4):673-678

258. Magalang UJ, Dmochowski J, Veeramachaneni S, Draw A, Mador MJ, El-Solh A et al. Prediction of the apnea-hypopnea index from overnight pulse oximetry. Chest. 2003; 124(5):1694-1701

259. Magnusdottir S, Hilmisson H. Ambulatory screening tool for sleep apnea: Analyzing a single-lead electrocardiogram signal (ECG). Sleep & Breathing. 2018; 22(2):421-429

260. Mahakit P. A comparative study of two-hour daytime and overnight polysomnography in high risk snorers. Journal of the Medical Association of Thailand. 2012; 95(Suppl 5):S17-22

261. Maier C, Dickhaus H. Recurrence analysis of nocturnal heart rate in sleep apnea patients. Biomedizinische Technik. 2006; 51(4):224-228

262. Maier C, Wenz H, Dickhaus H. Robust detection of sleep apnea from Holter ECGs. Joint assessment of modulations in QRS amplitude and respiratory myogram interference. Methods of Information in Medicine. 2014; 53(4):303-307

263. Maier C, Wenz H, Dickhaus H. Steps toward subject-specific classification in ECG-based detection of sleep apnea. Physiological Measurement. 2011; 32(11):1807-1819

264. Maimon N, Hanly PJ. Does snoring intensity correlate with the severity of obstructive sleep apnea? Journal of Clinical Sleep Medicine. 2010; 6(5):475-478

265. Maislin G, Pack AI, Kribbs NB, Smith PL, Schwartz AR, Kline LR et al. A survey screen for prediction of apnea. Sleep. 1995; 18(3):158-166

266. Makarie Rofail L, Wong KK, Unger G, Marks GB, Grunstein RR. Comparing the diagnostic accuracy of nasal flow and oximetry for OSA at home. American Journal of Respiratory and Critical Care Medicine. 2008; 177:A210

267. Malbois M, Giusti V, Suter M, Pellaton C, Vodoz JF, Heinzer R. Oximetry alone versus portable polygraphy for sleep apnea screening before bariatric surgery. Obesity Surgery. 2010; 20(3):326-331

268. Man GC, Kang BV. Validation of a portable sleep apnea monitoring device. Chest. 1995; 108(2):388-393

269. Mandal S, Suh ES, Boleat E, Asher W, Kamalanathan M, Lee K et al. A cohort study to identify simple clinical tests for chronic respiratory failure in obese patients with sleep-disordered breathing. BMJ open respiratory research. 2014; 1:e000022

270. Manoochehri Z, Rezaei M, Salari N, Khazaie H, Khaledi Paveh B, Manoochehri S. The prediction of obstructive sleep apnea using data mining approaches. Archives of Iranian Medicine. 2018; 21(10):460-465

271. Manoochehri Z, Salari N, Rezaei M, Khazaie H, Manoochehri S, Pavah BK. Comparison of support vector machine based on genetic algorithm with logistic regression to diagnose obstructive sleep apnea. Journal of Research in Medical Sciences. 2018; 23:65

272. Manser RL, Rochford P, Pierce RJ, Byrnes GB, Campbell DA. Impact of different criteria for defining hypopneas in the apnea-hypopnea index. Chest. 2001; 120(3):909-914

273. Manuel ARG, Hart N, Stradling JR. Is a raised bicarbonate, without hypercapnia, part of the physiologic spectrum of obesity-related hypoventilation? Chest. 2015; 147(2):362-368

274. Maranate T, Pongpullponsak A, Ruttanaumpawan P. The prioritization of clinical risk factors of obstructive sleep apnea severity using fuzzy analytic hierarchy process. Computational and Mathematical Methods in Medicine. 2015; 2015:257856

275. Marcos JV, Hornero R, Alvarez D, Aboy M, Del Campo F. Automated prediction of the apnea-hypopnea index from nocturnal oximetry recordings. IEEE Transactions on Biomedical Engineering. 2012; 59(1):141-149

276. Marcos JV, Hornero R, Alvarez D, Del Campo F, Aboy M. Automated detection of obstructive sleep apnoea syndrome from oxygen saturation recordings using linear discriminant analysis. Medical and Biological Engineering and Computing. 2010; 48(9):895-902

277. Marcos JV, Hornero R, Alvarez D, Del Campo F, Lopez M. Applying neural network classifiers in the diagnosis of the obstructive sleep apnea syndrome from nocturnal pulse oximetric recordings. Conference Proceedings: Annual International Conference of the IEEE Engineering in Medicine & Biology Society. 2007; 2007:5174-5177

278. Marcos JV, Hornero R, Alvarez D, del Campo F, Lopez M, Zamarron C. Radial basis function classifiers to help in the diagnosis of the obstructive sleep apnoea syndrome from nocturnal oximetry. Medical and Biological Engineering and Computing. 2008; 46(4):323-332

279. Marcos JV, Hornero R, Alvarez D, del Campo F, Zamarron C. Assessment of four statistical pattern recognition techniques to assist in obstructive sleep apnoea diagnosis from nocturnal oximetry. Medical Engineering and Physics. 2009; 31(8):971-978

280. Marcos JV, Hornero R, Alvarez D, Del Campo F, Zamarron C. A classification algorithm based on spectral features from nocturnal oximetry and support vector machines to assist in the diagnosis of obstructive sleep apnea. Conference Proceedings: Annual International Conference of the IEEE Engineering in Medicine & Biology Society. 2009; 2009:5547-5550

281. Marcos JV, Hornero R, Alvarez D, Del Campo F, Zamarron C, Lopez M. Utility of multilayer perceptron neural network classifiers in the diagnosis of the obstructive sleep apnoea syndrome from nocturnal oximetry. Computer Methods and Programs in Biomedicine. 2008; 92(1):79-89

282. Marcos JV, Hornero R, Alvarez D, Nabney IT, Del Campo F, Zamarron C. The classification of oximetry signals using Bayesian neural networks to assist in the detection of obstructive sleep apnoea syndrome. Physiological Measurement. 2010; 31(3):375-394

283. Marcos JV, Hornero R, Nabney IT, Alvarez D, Del Campo F. Analysis of nocturnal oxygen saturation recordings using kernel entropy to assist in sleep apnea-hypopnea diagnosis. Conference Proceedings: Annual International Conference of the IEEE Engineering in Medicine & Biology Society. 2011; 2011:1745-1748

284. Marcos JV, Hornero R, Nabney IT, Alvarez D, Gutierrez-Tobal GC, del Campo F. Regularity analysis of nocturnal oximetry recordings to assist in the diagnosis of sleep apnoea syndrome. Medical Engineering and Physics. 2016; 38(3):216-224

285. Margallo VS, Muxfeldt ES, Guimaraes GM, Salles GF. Diagnostic accuracy of the Berlin questionnaire in detecting obstructive sleep apnea in patients with resistant hypertension. Journal of Hypertension. 2014; 32(10):2030-2036; discussion 2037

286. Marrone O, Salvaggio A, Insalaco G, Bonsignore MR, Bonsignore G. Evaluation of the POLYMESAM system in the diagnosis of obstructive sleep apnea syndrome. Monaldi Archives for Chest Disease. 2001; 56(6):486-490

287. Marti-Soler H, Hirotsu C, Marques-Vidal P, Vollenweider P, Waeber G, Preisig M et al. The NoSAS score for screening of sleep-disordered breathing: A derivation and validation study. The Lancet Respiratory Medicine. 2016; 4(9):742-748

288. Martinez-Garcia MA, Navarro-Soriano C, Torres G, Barbe F, Caballero-Eraso C, Lloberes P et al. Beyond resistant hypertension. Hypertension. 2018; 72(3):618-624

289. Martinez D, Breitenbach TC, Lumertz MS, Alcantara DL, da Rocha NS, Cassol CM et al. Repeating administration of Epworth Sleepiness Scale is clinically useful. Sleep & Breathing. 2011; 15(4):763-773

290. Martinez D, da Silva RP, Klein C, Fiori CZ, Massierer D, Cassol CM et al. High risk for sleep apnea in the Berlin questionnaire and coronary artery disease. Sleep & Breathing. 2012; 16(1):89-94

291. Martinez D, Lumertz MS, Lenz Mdo C. Dimensions of sleepiness and their correlations with sleep-disordered breathing in mild sleep apnea. Jornal Brasileiro De Pneumologia : Publicacao Oficial Da Sociedade Brasileira De Pneumologia E Tisilogia. 2009; 35(6):507-514

292. Martinez MW, Rodysill KJ, Morgenthaler TI. Use of ambulatory overnight oximetry to investigate sleep apnea in a general internal medicine practice. Mayo Clinic Proceedings. 2005; 80(4):455-462

293. Martinot JB, Borel JC, Cuthbert V, Guenard HJ, Denison S, Silkoff PE et al. Mandibular position and movements: Suitability for diagnosis of sleep apnoea. Respirology. 2017; 22(3):567-574

294. Martinot JB, Le-Dong NN, Cuthbert V, Denison S, Silkoff PE, Guenard H et al. Mandibular movements as accurate reporters of respiratory effort during sleep: Validation against diaphragmatic electromyography. Frontiers in Neurology. 2017; 8:353

295. Martins EF, Martinez D, Cortes AL, Nascimento N, Brendler J. Exploring the STOP-BANG questionnaire for obstructive sleep apnea screening in seniors. Journal of Clinical Sleep Medicine. 2020; 16(2):199-206

296. Masa JF, Corral J, Gomez de Terreros J, Duran-Cantolla J, Cabello M, Hernandez-Blasco L et al. Significance of including a surrogate arousal for sleep apnea-hypopnea syndrome diagnosis by respiratory polygraphy. Sleep. 2013; 36(2):249-257

297. Masa JF, Corral J, Pereira R, Duran-Cantolla J, Cabello M, Hernandez-Blasco L et al. Effectiveness of sequential automatic-manual home respiratory polygraphy scoring. European Respiratory Journal. 2013; 41(4):879-887

298. Masa JF, Corral J, Pereira R, Duran-Cantolla J, Cabello M, Hernandez-Blasco L et al. Effectiveness of home respiratory polygraphy for the diagnosis of sleep apnoea and hypopnoea syndrome. Thorax. 2011; 66(7):567-573

299. Masa JF, Corral J, Pereira R, Duran-Cantolla J, Cabello M, Hernandez-Blasco L et al. Therapeutic decision-making for sleep apnea and hypopnea syndrome using home respiratory polygraphy: A large multicentric study. American Journal of Respiratory and Critical Care Medicine. 2011; 184(8):964-971

300. Masa JF, Corral J, Sanchez de Cos J, Duran-Cantolla J, Cabello M, Hernandez-Blasco L et al. Effectiveness of three sleep apnea management alternatives. Sleep. 2013; 36(12):1799-1807

301. Masa JF, Duran-Cantolla J, Capote F, Cabello M, Abad J, Garcia-Rio F et al. Effectiveness of home single-channel nasal pressure for sleep apnea diagnosis. Sleep. 2014; 37(12):1953-1961

302. Massie F, De Almeida DM, Dreesen P, Thijs I, Vranken J, Klerkx S. An evaluation of the Night Owl home sleep apnea testing system. Journal of Clinical Sleep Medicine. 2018; 14(10):1791-1796

303. Maury G, Cambron L, Jamart J, Marchand E, Senny F, Poirrier R. Added value of a mandible movement automated analysis in the screening of obstructive sleep apnea. Journal of Sleep Research. 2013; 22(1):96-103

304. Maury G, Senny F, Cambron L, Albert A, Seidel L, Poirrier R. Mandible behaviour interpretation during wakefulness, sleep and sleep-disordered breathing. Journal of Sleep Research. 2014; 23(6):709-716

305. Mayer P, Herrero Babiloni A, Aube JL, Kaddaha Z, Marshansky S, Rompre PH et al. Autonomic arousals as surrogates for cortical arousals caused by respiratory events: A methodological optimization study in the diagnosis of sleep breathing disorders. Nature & Science of Sleep. 2019; 11:423-431

306. Mayer P, Meurice JC, Philip-Joet F, Cornette A, Rakotonanahary D, Meslier N et al. Simultaneous laboratory-based comparison of ResMed Autoset with polysomnography in the diagnosis of sleep apnoea/hypopnoea syndrome. European Respiratory Journal. 1998; 12(4):770-775

307. Maziere S, Pepin JL, Siyanko N, Bioteau C, Launois S, Tamisier R et al. Usefulness of oximetry for sleep apnea screening in frail hospitalized elderly. Journal of the American Medical Directors Association. 2014; 15(6):447.e449-414

308. Mazza A, Bendini MG, De Cristofaro R, Lovecchio M, Valsecchi S, Boriani G. Pacemaker-detected severe sleep apnea predicts new-onset atrial fibrillation. Europace: European Pacing, Arrhythmias, and Cardiac Electrophysiology. 2017; 19(12):1937-1943

309. McArdle N, Grove A, Devereux G, Mackay-Brown L, Mackay T, Douglas NJ. Split-night versus full-night studies for sleep apnoea/hypopnoea syndrome. European Respiratory Journal. 2000; 15(4):670-675

310. McArdle N, Ward SV, Bucks RS, Maddison K, Smith A, Huang RC et al. The prevalence of common sleep disorders in young adults: a descriptive population-based study. Sleep. 2020; http://dx.doi.org/10.1093/sleep/zsaa072

311. McCall WV, Kimball J, Boggs N, Lasater B, D'Agostino RB, Jr., Rosenquist PB. Prevalence and prediction of primary sleep disorders in a clinical trial of depressed patients with insomnia. Journal of Clinical Sleep Medicine. 2009; 5(5):454-458

312. McCarter SJ, St Louis EK, Duwell EJ, Timm PC, Sandness DJ, Boeve BF et al. Diagnostic thresholds for quantitative REM sleep phasic burst duration, phasic and tonic muscle activity, and REM atonia index in REM sleep behavior disorder with and without comorbid obstructive sleep apnea. Sleep. 2014; 37(10):1649-1662

313. McIsaac DI, Gershon A, Wijeysundera D, Bryson GL, Badner N, van Walraven C. Identifying obstructive sleep apnea in administrative data: A study of diagnostic accuracy. Anesthesiology. 2015; 123(2):253-263

314. McMahon MJ, Sheikh KL, Andrada TF, Holley AB. Using the STOPBANG questionnaire and other pre-test probability tools to predict OSA in younger, thinner patients referred to a sleep medicine clinic. Sleep & Breathing. 2017; 21(4):869-876

315. McMillan A, Bratton DJ, Faria R, Laskawiec-Szkonter M, Griffin S, Davies RJ et al. A multicentre randomised controlled trial and economic evaluation of continuous positive airway pressure for the treatment of obstructive sleep apnoea syndrome in older people: PREDICT. Health Technology Assessment. 2015; 19(40):1-220

316. Medarov BI, Pluto LA, Fina L, Ilyas F, Sukhu I, Yucel R et al. Assessing the reliability of obstructive sleep apnea screening instruments in isolation or in combination. Respiratory Medicine: X. 2020; 2:100019

317. Mehra R, Stone KL, Ancoli-Israel S, Litwack-Harrison S, Ensrud KE, Redline S et al. Interpreting wrist actigraphic indices of sleep in epidemiologic studies of the elderly: the Study of Osteoporotic Fractures. Sleep. 2008; 31(11):1569-1576

318. Meissner WG, Flabeau O, Perez P, Taillard J, Marquant F, Dupouy S et al. Accuracy of portable polygraphy for the diagnosis of sleep apnea in multiple system atrophy. Sleep Medicine. 2014; 15(4):476-479

319. Mendelson WB. Use of the sleep laboratory in suspected sleep apnea syndrome: is one night enough? Cleveland Clinic Journal of Medicine. 1994; 61(4):299-303

320. Mendez MO, Corthout J, Van Huffel S, Matteucci M, Penzel T, Cerutti S et al. Automatic screening of obstructive sleep apnea from the ECG based on empirical mode decomposition and wavelet analysis. Physiological Measurement. 2010; 31(3):273-289

321. Meng L, Xu H, Guan J, Yi H, Wu H, Yin S. Validation of a novel sleep-monitoring system for diagnosing obstructive sleep apnea: A comparison with polysomnography. Experimental and Therapeutic Medicine. 2016; 12(5):2937-2941

322. Mergen H, Altindag B, Zeren Ucar Z, Karasu Kilicaslan I. The predictive performance of the STOP-Bang questionnaire in obstructive sleep apnea screening of obese population at sleep clinical setting. Cureus. 2019; 11(12):e6498

323. Mesquita J, Sola-Soler J, Fiz JA, Morera J, Jane R. All night analysis of time interval between snores in subjects with sleep apnea hypopnea syndrome. Medical and Biological Engineering and Computing. 2012; 50(4):373-381

324. Methipisit T, Mungthin M, Saengwanitch S, Ruangkana P, Chinwarun Y, Ruangkanchanasetr P et al. The Development of sleep questionnaires Thai version (ESS, SA-SDQ, and PSQI): Linguistic validation, reliability analysis and cut-Off level to determine sleep related problems in Thai population. Journal of the Medical Association of Thailand. 2016; 99(8):893-903

325. Meurgey JH, Brown R, Woroszyl-Chrusciel A, Steier J. Peri-operative treatment of sleep-disordered breathing and outcomes in bariatric patients. Journal of Thoracic Disease. 2018; 10(Suppl 1):S144-152

326. Michaelson PG, Allan P, Chaney J, Mair EA. Validations of a portable home sleep study with twelve-lead polysomnography: Comparisons and insights into a variable gold standard. Annals of Otology, Rhinology and Laryngology. 2006; 115(11):802-809

327. Mihaicuta S, Udrescu M, Topirceanu A, Udrescu L. Network science meets respiratory medicine for OSAS phenotyping and severity prediction. PeerJ. 2017; 5:e3289

328. Miller JN, Kupzyk KA, Zimmerman L, Pozehl B, Schulz P, Romberger D et al. Comparisons of measures used to screen for obstructive sleep apnea in patients referred to a sleep clinic. Sleep Medicine. 2018; 51:15-21

329. Miller JN, Schulz P, Pozehl B, Fiedler D, Fial A, Berger AM. Methodological strategies in using home sleep apnea testing in research and practice. Sleep & Breathing. 2018; 22(3):569-577

330. Minic M, Granton JT, Ryan CM. Sleep disordered breathing in group 1 pulmonary arterial hypertension. Journal of Clinical Sleep Medicine. 2014; 10(3):277-283

331. Miyata S, Otake H, Ando M, Okuda M, Fujishiro H, Iwamoto K et al. Patient characteristics affecting accurate detection of sleep apnea using a bed sheet-type portable monitor. Sleep and Breathing. 2020; 24(2):783-790

332. Mokhlesi B, Tulaimat A, Faibussowitsch I, Wang Y, Evans AT. Obesity hypoventilation syndrome: Prevalence and predictors in patients with obstructive sleep apnea. Sleep & Breathing. 2007; 11(2):117-124

333. Morales CR, Hurley S, Wick LC, Staley B, Pack FM, Gooneratne NS et al. In-home, self-assembled sleep studies are useful in diagnosing sleep apnea in the elderly. Sleep. 2012; 35(11):1491-1501

334. Morales Divo C, Selivanova O, Mewes T, Gosepath J, Lippold R, Mann WJ. Polysomnography and ApneaGraph in patients with sleep-related breathing disorders. ORL: Journal of Oto-Rhino-Laryngology and Its Related Specialties. 2009; 71(1):27-31

335. Morgan BJ, Reichmuth KJ, Peppard PE, Finn L, Barczi SR, Young T et al. Effects of sleep-disordered breathing on cerebrovascular regulation: A population-based study. American Journal of Respiratory and Critical Care Medicine. 2010; 182(11):1445-1452

336. Morgenstern C, Randerath WJ, Schwaibold M, Bolz A, Jane R. Feasibility of noninvasive single-channel automated differentiation of obstructive and central hypopneas with nasal airflow. Respiration. 2013; 85(4):312-318

337. Morgenstern C, Schwaibold M, Randerath WJ, Bolz A, Jane R. An invasive and a noninvasive approach for the automatic differentiation of obstructive and central hypopneas. IEEE Transactions on Biomedical Engineering. 2010; 57(8):1927-1936

338. Morillo DS, Gross N. Probabilistic neural network approach for the detection of SAHS from overnight pulse oximetry. Medical and Biological Engineering and Computing. 2013; 51(3):305-315

339. Morillo DS, Rojas JL, Crespo LF, Leon A, Gross N. Poincare analysis of an overnight arterial oxygen saturation signal applied to the diagnosis of sleep apnea hypopnea syndrome. Physiological Measurement. 2009; 30(4):405-420

340. Moro M, Westover MB, Kelly J, Bianchi MT. Decision modeling in sleep apnea: The critical roles of pretest probability, cost of untreated obstructive sleep apnea, and time horizon. Journal of Clinical Sleep Medicine. 2016; 12(3):409-418

341. Morrell MJ, Finn L, McMillan A, Peppard PE. The impact of ageing and sex on the association between sleepiness and sleep disordered breathing. European Respiratory Journal. 2012; 40(2):386-393

342. Morris LG, Burschtin O, Lebowitz RA, Jacobs JB, Lee KC. Nasal obstruction and sleep-disordered breathing: A study using acoustic rhinometry. American Journal of Rhinology. 2005; 19(1):33-39

343. Morris LG, Kleinberger A, Lee KC, Liberatore LA, Burschtin O. Rapid risk stratification for obstructive sleep apnea, based on snoring severity and body mass index. Otolaryngology - Head and Neck Surgery. 2008; 139(5):615-618

344. Mou J, Pflugeisen BM, Crick BA, Amoroso PJ, Harmon KT, Tarnoczy SF et al. The discriminative power of STOP-Bang as a screening tool for suspected obstructive sleep apnea in clinically referred patients: Considering gender differences Sleep & Breathing. 2019; 23(1):65-75

345. Mueller A, Fietze I, Voelker R, Eddicks S, Glos M, Baumann G et al. Screening for sleep-related breathing disorders by transthoracic impedance recording integrated into a Holter ECG system. Journal of Sleep Research. 2006; 15(4):455-462

346. Mulgrew AT, Fox N, Ayas NT, Ryan CF. Diagnosis and initial management of obstructive sleep apnea without polysomnography: a randomized validation study. Annals of Internal Medicine. 2007; 146(3):157-166

347. Munoz-Ferrer A, Cervantes MA, Garcia-Olive I, Vicente I, Folgadob C, Ruiz-Manzano J et al. In-home diagnosis of obstructive sleep apnea using automatic video analysis. Archivos de Bronconeumologia. 2020; http://dx.doi.org/10.1016/j.arbres.2019.11.027

348. Musman S, Passos VM, Silva IB, Barreto SM. Evaluation of a prediction model for sleep apnea in patients submitted to polysomnography. Jornal Brasileiro De Pneumologia : Publicacao Oficial Da Sociedade Brasileira De Pneumologia E Tisilogia. 2011; 37(1):75-84

349. Mutlu P, Zateri C, Zohra A, Ozerdogan O, Mirici AN. Prevalence of obstructive sleep apnea in female patients with fibromyalgia. Saudi Medical Journal. 2020; 41(7):740-745

350. Nagappa M, Liao P, Wong J, Auckley D, Ramachandran SK, Memtsoudis S et al. Validation of the stop-bang questionnaire as a screening tool for obstructive sleep apnea among different populations: A systematic review and meta-analysis. PloS One. 2015; 10(12):e0143697

351. Nagubadi S, Mehta R, Abdoh M, Nagori M, Littleton S, Gueret R et al. The accuracy of portable monitoring in diagnosing significant sleep disordered breathing in hospitalized patients. PloS One. 2016; 11(12):e0168073

352. Nahapetian R, Silva GE, Vana KD, Parthasarathy S, Quan SF. Weighted STOP-Bang and screening for sleep-disordered breathing. Sleep & Breathing. 2016; 20(2):597-603

353. Nakano H, Furukawa T, Nishima S. Relationship between snoring sound intensity and sleepiness in patients with obstructive sleep apnea. Journal of Clinical Sleep Medicine. 2008; 4(6):551-556

354. Nakano H, Hayashi M, Ohshima E, Nishikata N, Shinohara T. Validation of a new system of tracheal sound analysis for the diagnosis of sleep apnea-hypopnea syndrome. Sleep. 2004; 27(5):951-957

355. Nakano H, Hirayama K, Sadamitsu Y, Toshimitsu A, Fujita H, Shin S et al. Monitoring sound to quantify snoring and sleep apnea severity using a smartphone: Proof of concept. Journal of Clinical Sleep Medicine. 2014; 10(1):73-78

356. Nakano H, Ikeda T, Hayashi M, Ohshima E, Itoh M, Nishikata N et al. Effect of body mass index on overnight oximetry for the diagnosis of sleep apnea. Respiratory Medicine. 2004; 98(5):421-427

357. Nakano H, Tanigawa T, Furukawa T, Nishima S. Automatic detection of sleep-disordered breathing from a single-channel airflow record. European Respiratory Journal. 2007; 29(4):728-736

358. Nakano H, Tanigawa T, Ohnishi Y, Uemori H, Senzaki K, Furukawa T et al. Validation of a single-channel airflow monitor for screening of sleep-disordered breathing. European Respiratory Journal. 2008; 32(4):1060-1067

359. Narayan S, Shivdare P, Niranjan T, Williams K, Freudman J, Sehra R. Noncontact identification of sleep-disturbed breathing from smartphone-recorded sounds validated by polysomnography Sleep & Breathing. 2019; 23(1):269-279

360. National Institute for Health and Care Excellence. Developing NICE guidelines: the manual [Updated 2018]. London. National Institute for Health and Care Excellence, 2014. Available from: http://www.nice.org.uk/article/PMG20/chapter/1%20Introduction%20and%20overview

361. National Institute for Health and Care Excellence. Preoperative tests (update): routine preoperative tests for elective surgery. NICE guideline 45. London. National Institute for Health and Care Excellence, 2016. Available from: https://www.nice.org.uk/guidance/ng45

362. National Institute for Health and Clinical Excellence. Continuous positive airway pressure for the treatment of obstructive sleep apnoea/hypopnoea syndrome . NICE technology appraisal guidance 139. London. National Institute for Health and Clinical Excellence, 2008. Available from: http://guidance.nice.org.uk/TA139

363. Netzer NC, Stoohs RA, Netzer CM, Clark K, Strohl KP. Using the Berlin Questionnaire to identify patients at risk for the sleep apnea syndrome. Annals of Internal Medicine. 1999; 131(7):485-491

364. Ng AK, Koh TS, Abeyratne UR, Puvanendran K. Investigation of obstructive sleep apnea using nonlinear mode interactions in nonstationary snore signals. Annals of Biomedical Engineering. 2009; 37(9):1796-1806

365. Ng AK, Koh TS, Baey E, Lee TH, Abeyratne UR, Puvanendran K. Could formant frequencies of snore signals be an alternative means for the diagnosis of obstructive sleep apnea? Sleep Medicine. 2008; 9(8):894-898

366. Ng AK, Koh TS, Baey E, Puvanendran K. Role of upper airway dimensions in snore production: Acoustical and perceptual findings. Annals of Biomedical Engineering. 2009; 37(9):1807-1817

367. Ng AK, Wong KY, Tan CH, Koh TS. Bispectral analysis of snore signals for obstructive sleep apnea detection. Conference Proceedings: Annual International Conference of the IEEE Engineering in Medicine & Biology Society. 2007; 2007:6196-6199

368. Ng SS, Chan TO, To KW, Ngai J, Tung A, Ko FW et al. Validation of a portable recording device (ApneaLink) for identifying patients with suspected obstructive sleep apnoea syndrome. Internal Medicine Journal. 2009; 39(11):757-762

369. Ng SS, Chan TO, To KW, Ngai J, Tung A, Ko FW et al. Validation of Embletta portable diagnostic system for identifying patients with suspected obstructive sleep apnoea syndrome (OSAS). Respirology. 2010; 15(2):336-342

370. Ng SS, Tam W, Chan TO, To KW, Ngai J, Chan KKP et al. Use of Berlin questionnaire in comparison to polysomnography and home sleep study in patients with obstructive sleep apnea. Respiratory Research. 2019; 20(1):40

371. Ng Y, Joosten SA, Edwards BA, Turton A, Romios H, Samarasinghe T et al. Oxygen desaturation index differs significantly between types of sleep software. Journal of Clinical Sleep Medicine. 2017; 13(4):599-605

372. NHS. NHS Supply Chain Catalogue. NHS Supply Chain, 2018. Available from: http://www.supplychain.nhs.uk/

373. NHS. NHS Supply Chain Catalogue. 2020. Available from: http://www.supplychain.nhs.uk/ Last accessed: 07/07/2020.

374. NHS Improvement. 2017/18 Reference costs and guidance. 2018. Available from: https://improvement.nhs.uk/resources/reference-costs/ Last accessed: 02/01/2019.

375. Nicholl DD, Ahmed SB, Loewen AH, Hemmelgarn BR, Sola DY, Beecroft JM et al. Diagnostic value of screening instruments for identifying obstructive sleep apnea in kidney failure. Journal of Clinical Sleep Medicine. 2013; 9(1):31-38

376. Nicholl DDM, Ahmed SB, Loewen AHS, Hemmelgarn BR, Sola DY, Beecroft JM et al. Declining kidney function increases the prevalence of sleep apnea and nocturnal hypoxia. Chest. 2012; 141(6):1422-1430

377. Nigro CA, Aimaretti S, Gonzalez S, Rhodius E. Validation of the WristOx 3100 oximeter for the diagnosis of sleep apnea/hypopnea syndrome. Sleep & Breathing. 2009; 13(2):127-136

378. Nigro CA, Borsini EE, Dibur E, Larrateguy LD, Cazaux A, Elias C et al. CPAP indication based on clinical data and oximetry for patients with suspicion of obstructive sleep apnea: A multicenter trial. Sleep Science. 2019; 12(4):249-256

379. Nigro CA, Dibur E, Aimaretti S, Gonzalez S, Rhodius E. Comparison of the automatic analysis versus the manual scoring from ApneaLinkTM device for the diagnosis of obstructive sleep apnoea syndrome. Sleep & Breathing. 2011; 15(4):679-686

380. Nigro CA, Dibur E, Aragone MR, Borsini E, Ernst G, Nogueria F. Can CPAP be indicated in adult patients with suspected obstructive sleep apnea only on the basis of clinical data? Sleep & Breathing. 2016; 20(1):175-182; discussion 182

381. Nigro CA, Dibur E, Grandval S, Nogueira F. Indication of cpap in patients with suspected obstructive sleep apnea, based on clinical parameters and a novel two-channel recording device (ApneaLink): A pilot study. Sleep Disorders Print. 2012; 2012:346181

382. Nigro CA, Dibur E, Malnis S, Grandval S, Nogueira F. Validation of ApneaLink OxTM for the diagnosis of obstructive sleep apnea. Sleep & Breathing. 2013; 17(1):259-266

383. Nigro CA, Dibur E, Rhodius E. Accuracy of the clinical parameters and oximetry to initiate CPAP in patients with suspected obstructive sleep apnea. Sleep & Breathing. 2012; 16(4):1073-1079

384. Nigro CA, Dibur E, Rhodius E. Pulse oximetry for the detection of obstructive sleep apnea syndrome: Can the memory capacity of oxygen saturation influence their diagnostic accuracy? Sleep Disorders Print. 2011; 2011:427028

385. Nigro CA, Gonzalez S, Arce A, Aragone MR, Nigro L. Accuracy of a novel auto-CPAP device to evaluate the residual apnea-hypopnea index in patients with obstructive sleep apnea. Sleep & Breathing. 2015; 19(2):569-578

386. Nigro CA, Malnis S, Dibur E, Rhodius E. How reliable is the manual correction of the autoscoring of a level IV sleep study (ApneaLinkTM) by an observer without experience in polysomnography? Sleep & Breathing. 2012; 16(2):275-279

387. Nigro CA, Serrano F, Aimaretti S, Gonzalez S, Codinardo C, Rhodius E. Utility of ApneaLink for the diagnosis of sleep apnea-hypopnea syndrome. Medicina. 2010; 70(1):53-59

388. Niijima K, Enta K, Hori H, Sashihara S, Mizoue T, Morimoto Y. The usefulness of sleep apnea syndrome screening using a portable pulse oximeter in the workplace. Journal of Occupational Health. 2007; 49(1):1-8

389. Nilius G, Domanski U, Schroeder M, Franke KJ, Hogrebe A, Margarit L et al. A randomized controlled trial to validate the Alice PDX ambulatory device. Nature & Science of Sleep. 2017; 9:171-180

390. Nishiyama T, Mizuno T, Kojima M, Suzuki S, Kitajima T, Ando KB et al. Criterion validity of the Pittsburgh Sleep Quality Index and Epworth Sleepiness Scale for the diagnosis of sleep disorders. Sleep Medicine. 2014; 15(4):422-429

391. Norman MB, Sullivan CE. Estimating sleep time from non-EEG-based PSG signals in the diagnosis of sleep-disordered breathing. Sleep & Breathing. 2017; 21(3):657-666

392. Novkovic D, Cvetkovic G, Acimovic S, Milic R, Sarac S, Urosevic R. Using respiratory polygraphy in diagnosing obstructive sleep apnea - Our experiences. Vojnosanitetski Pregled. 2019; 76(11):1190-1193

393. O'Brien C, Heneghan C. A comparison of algorithms for estimation of a respiratory signal from the surface electrocardiogram. Computers in Biology and Medicine. 2007; 37(3):305-314

394. O'Driscoll DM, Turton AR, Copland JM, Strauss BJ, Hamilton GS. Energy expenditure in obstructive sleep apnea: Validation of a multiple physiological sensor for determination of sleep and wake. Sleep & Breathing. 2013; 17(1):139-146

395. Oeverland B, Skatvedt O, Kvaerner KJ, Akre H. Pulseoximetry: Sufficient to diagnose severe sleep apnea. Sleep Medicine. 2002; 3(2):133-138

396. Oktay B, Rice TB, Atwood CW, Jr., Passero M, Jr., Gupta N, Givelber R et al. Evaluation of a single-channel portable monitor for the diagnosis of obstructive sleep apnea. Journal of Clinical Sleep Medicine. 2011; 7(4):384-390

397. Oliveira MG, Nery LE, Santos-Silva R, Sartori DE, Alonso FF, Togeiro SM et al. Is portable monitoring accurate in the diagnosis of obstructive sleep apnea syndrome in chronic pulmonary obstructive disease? Sleep Medicine. 2012; 13(8):1033-1038

398. Oliveira MG, Treptow EC, Fukuda C, Nery LE, Valadares RM, Tufik S et al. Diagnostic accuracy of home-based monitoring system in morbidly obese patients with high risk for sleep apnea. Obesity Surgery. 2015; 25(5):845-851

399. Olson LG, Ambrogetti A, Gyulay SG. Prediction of sleep-disordered breathing by unattended overnight oximetry. Journal of Sleep Research. 1999; 8(1):51-55

400. Onder NS, Akpinar ME, Yigit O, Gor AP. Watch peripheral arterial tonometry in the diagnosis of obstructive sleep apnea: influence of aging. Laryngoscope. 2012; 122(6):1409-1414

401. Onen SH, Dubray C, Decullier E, Moreau T, Chapuis F, Onen F. Observation-based nocturnal sleep inventory: Screening tool for sleep apnea in elderly people. Journal of the American Geriatrics Society. 2008; 56(10):1920-1925

402. Ong TH, Raudha S, Fook-Chong S, Lew N, Hsu AAL. Simplifying STOP-BANG: Use of a simple questionnaire to screen for OSA in an Asian population. Sleep & Breathing. 2010; 14(4):371-376

403. Ontario Ministry of Health and Long-Term Care. Polysomnography in patients with obstructive sleep apnea. Ontario. 2006. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3379160/pdf/ohtas-06-38a.pdf

404. Organisation for Economic Co-operation and Development (OECD). Purchasing power parities (PPP). Available from: https://doi.org/10.1787/1290ee5a-en Last accessed: 06/07/2020.

405. Ortiz-Tudela E, Martinez-Nicolas A, Albares J, Segarra F, Campos M, Estivill E et al. Ambulatory Circadian Monitoring (ACM) based on Thermometry, motor Activity and body Position (TAP): A comparison with polysomnography. Physiology and Behavior. 2014; 126:30-38

406. Ozegowski S, Wilczynska E, Piorunek T, Szymanowska K, Paluszkiewicz L. Usefulness of ambulatory ECG in the diagnosis of sleep-related breathing disorders. Kardiologia Polska. 2007; 65(11):1321-1328; discussion 1329-1330

407. Ozmen OA, Tuzemen G, Kasapoglu F, Ozmen S, Coskun H, Ursavas A et al. The reliability of SleepStrip as a screening test in obstructive sleep apnea syndrome. Journal of Ear, Nose & Throat: KBB. 2011; 21(1):15-19

408. Pallin M, O'Hare E, Zaffaroni A, Boyle P, Fagan C, Kent B et al. Comparison of a novel non-contact biomotion sensor with wrist actigraphy in estimating sleep quality in patients with obstructive sleep apnoea. Journal of Sleep Research. 2014; 23(4):475-484

409. Pamidi S, Knutson KL, Ghods F, Mokhlesi B. Depressive symptoms and obesity as predictors of sleepiness and quality of life in patients with REM-related obstructive sleep apnea: Cross-sectional analysis of a large clinical population. Sleep Medicine. 2011; 12(9):827-831

410. Panchasara B, Poots AJ, Davies G. Are the Epworth Sleepiness Scale and Stop-Bang model effective at predicting the severity of obstructive sleep apnoea (OSA); in particular OSA requiring treatment? European Archives of Oto-Rhino-Laryngology. 2017; 274(12):4233-4239

411. Pang KP, Dillard TA, Blanchard AR, Gourin CG, Podolsky R, Terris DJ. A comparison of polysomnography and the SleepStrip in the diagnosis of OSA. Otolaryngology - Head and Neck Surgery. 2006; 135(2):265-268

412. Pang KP, Gourin CG, Terris DJ. A comparison of polysomnography and the WatchPAT in the diagnosis of obstructive sleep apnea. Otolaryngology - Head and Neck Surgery. 2007; 137(4):665-668

413. Park DY, Kim HJ, Kim CH, Kim YS, Choi JH, Hong SY et al. Reliability and validity testing of automated scoring in obstructive sleep apnea diagnosis with the Embletta X100. Laryngoscope. 2015; 125(2):493-497

414. Park JU, Lee HK, Lee J, Urtnasan E, Kim H, Lee KJ. Automatic classification of apnea/hypopnea events through sleep/wake states and severity of SDB from a pulse oximeter. Physiological Measurement. 2015; 36(9):2009-2025

415. Parra O, Garcia-Esclasans N, Montserrat JM, Garcia Eroles L, Ruiz J, Lopez JA et al. Should patients with sleep apnoea/hypopnoea syndrome be diagnosed and managed on the basis of home sleep studies? European Respiratory Journal. 1997; 10(8):1720-1724

416. Passali FM, Bellussi L, Mazzone S, Passali D. Predictive role of nasal functionality tests in the evaluation of patients before nocturnal polysomnographic recording. Acta Otorhinolaryngologica Italica. 2011; 31(2):103-108

417. Pataka A, Daskalopoulou E, Kalamaras G, Fekete Passa K, Argyropoulou P. Evaluation of five different questionnaires for assessing sleep apnea syndrome in a sleep clinic. Sleep Medicine. 2014; 15(7):776-781

418. Pataka A, Kalamaras G, Daskalopoulou E, Argyropoulou P. Sleep questionnaires for the screening of obstructive sleep apnea in patients with type 2 diabetes mellitus compared with non-diabetic patients. Journal of Diabetes. 2019; 11(3):214-222

419. Pataka A, Kotoulas S, Kalamaras G, Schiza S, Sapalidis K, Giannakidis D et al. Gender differences in obstructive sleep apnea: The value of sleep questionnaires with a separate analysis of cardiovascular patients. Journal of Clinical Medicine. 2020; 9:130

420. Pataka A, Zarogoulidis P, Hohenforst-Schmidt W, Tsiouda T, Tsavlis D, Kioumis I et al. During economic crisis can sleep questionnaires improve the value of oximetry for assessing sleep apnea? Annals of Translational Medicine. 2016; 4(22):443

421. Patout M, Gagnadoux F, Rabec C, Trzepizur W, Georges M, Perrin C et al. AVAPS-AE versus ST mode: A randomized controlled trial in patients with obesity hypoventilation syndrome. Respirology. 2020; 25(10):1073-1081

422. Peker Y, Basoglu OK, Firat H, Turkapne Study Group. Rationale and design of the Turkish Sleep Apnea Database - TURKAPNE: A national, multicenter, observational, prospective cohort study. Turkish Thoracic Journal. 2018; 19(3):136-140

423. Pelletier-Fleury N, Gagnadoux F, Philippe C, Rakotonanahary D, Lanoe JL, Fleury B. A cost-minimization study of telemedicine. The case of telemonitored polysomnography to diagnose obstructive sleep apnea syndrome. International Journal of Technology Assessment in Health Care. 2001; 17(4):604-611

424. Penacoba P, Llauger MA, Fortuna AM, Flor X, Sampol G, Pedro-Pijoan AM et al. Primary care and sleep unit agreement in management decisions for sleep apnea: a prospective study in Spain. Journal of Clinical Sleep Medicine. 2020; http://dx.doi.org/10.5664/jcsm.8492

425. Peng M, Chen R, Cheng J, Li J, Liu W, Hong C. Application value of the NoSAS score for screening sleep-disordered breathing. Journal of Thoracic Disease. 2018; 10(8):4774-4781

426. Penzel T, Fricke R, Jerrentrup A, Peter JH, Vogelmeier C. Peripheral arterial tonometry for the diagnosis of obstructive sleep apnea. Biomedizinische Technik. 2002; 47(Suppl 1 Pt 1):315-317

427. Penzel T, Kesper K, Pinnow I, Becker HF, Vogelmeier C. Peripheral arterial tonometry, oximetry and actigraphy for ambulatory recording of sleep apnea. Physiological Measurement. 2004; 25(4):1025-1036

428. Penzel T, Kesper K, Ploch T, Becker HF, Vogelmeier C. Ambulatory recording of sleep apnea using peripheral arterial tonometry. Conference Proceedings: Annual International Conference of the IEEE Engineering in Medicine & Biology Society. 2004; 2004:3856-3859

429. Pepin JL, Defaye P, Vincent E, Christophle-Boulard S, Tamisier R, Levy P. Sleep apnea diagnosis using an ECG Holter device including a nasal pressure (NP) recording: Validation of visual and automatic analysis of nasal pressure versus full polysomnography. Sleep Medicine. 2009; 10(6):651-656

430. Pereira EJ, Driver HS, Stewart SC, Fitzpatrick MF. Comparing a combination of validated questionnaires and level III portable monitor with polysomnography to diagnose and exclude sleep apnea. Journal of Clinical Sleep Medicine. 2013; 9(12):1259-1266

431. Peto N, Seres T, Szakacs Z, Fay V, Karaszova J, Kontra A et al. Evaluation of the Brussells questionnaire as a screening tool for obstructive sleep apnea syndrome. New Medicine. 2017; 21(1):3-7

432. Phua CQ, Jang IJ, Tan KB, Hao Y, Senin SRB, Song PR et al. Reducing cost and time to diagnosis and treatment of obstructive sleep apnea using ambulatory sleep study: a Singapore sleep centre experience. Sleep & Breathing. 2020; https://dx.doi.org/10.1007/s11325-020-02115-z

433. Pichel F, Zamarron C, Magan F, Rodriguez JR. Sustained attention measurements in obstructive sleep apnea and risk of traffic accidents. Respiratory Medicine. 2006; 100(6):1020-1027

434. Pietzsch JB, Garner A, Cipriano LE, Linehan JH. An integrated health-economic analysis of diagnostic and therapeutic strategies in the treatment of moderate-to-severe obstructive sleep apnea. Sleep. 2011; 34(6):695-709

435. Pihtili A, Bingol Z, Kiyan E. The predictors of obesity hypoventilation syndrome in obstructive sleep apnea. Balkan Medical Journal. 2017; 34(1):41-46

436. Pillar G, Peled N, Katz N, Lavie P. Predictive value of specific risk factors, symptoms and signs, in diagnosing obstructive sleep apnoea and its severity. Journal of Sleep Research. 1994; 3(4):241-244

437. Pinna GD, Robbi E, Pizza F, Taurino AE, Pronzato C, La Rovere MT et al. Can cardiorespiratory polygraphy replace portable polysomnography in the assessment of sleep-disordered breathing in heart failure patients? Sleep & Breathing. 2014; 18(3):475-482

438. Pinto JA, Godoy LB, Ribeiro RC, Mizoguchi EI, Hirsch LA, Gomes LM. Accuracy of peripheral arterial tonometry in the diagnosis of obstructive sleep apnea. Revista Brasileira de Otorrinolaringologia. 2015; 81(5):473-478

439. Pissulin FDM, Pacagnelli FL, Alda MA, Beneti R, Barros JL, Minamoto ST et al. The triad of obstructive sleep apnea syndrome, COPD, and obesity: Sensitivity of sleep scales and respiratory questionnaires. Jornal Brasileiro De Pneumologia : Publicacao Oficial Da Sociedade Brasileira De Pneumologia E Tisilogia. 2018; 44(3):202-206

440. Pittman SD, Ayas NT, MacDonald MM, Malhotra A, Fogel RB, White DP. Using a wrist-worn device based on peripheral arterial tonometry to diagnose obstructive sleep apnea: In-laboratory and ambulatory validation. Sleep. 2004; 27(5):923-933

441. Pittman SD, MacDonald MM, Fogel RB, Malhotra A, Todros K, Levy B et al. Assessment of automated scoring of polysomnographic recordings in a population with suspected sleep-disordered breathing. Sleep. 2004; 27(7):1394-1403

442. Planes C, Leroy M, Bouach Khalil N, El Mahmoud R, Digne F, De Roquefeuil F et al. Home diagnosis of obstructive sleep apnoea in coronary patients: Validity of a simplified device automated analysis. Sleep & Breathing. 2010; 14(1):25-32

443. Polese JF, Santos-Silva R, de Oliveira Ferrari PM, Sartori DE, Tufik S, Bittencourt L. Is portable monitoring for diagnosing obstructive sleep apnea syndrome suitable in elderly population? Sleep & Breathing. 2013; 17(2):679-686

444. Popovic D, King C, Guerrero M, Levendowski DJ, Henninger D, Westbrook PR. Validation of forehead venous pressure as a measure of respiratory effort for the diagnosis of sleep apnea. Journal of Clinical Monitoring and Computing. 2009; 23:1-10

445. Pouliot Z, Peters M, Neufeld H, Kryger MH. Using self-reported questionnaire data to prioritize OSA patients for polysomnography. Sleep. 1997; 20(3):232-236

446. Poupard L, Mathieu M, Goldman M, Chouchou F, Roche F. Multi-modal ECG Holter system for sleep-disordered breathing screening: A validation study. Sleep & Breathing. 2012; 16(3):685-693

447. Poupard L, Philippe C, Goldman MD, Sartene R, Mathieu M. Novel mathematical processing method of nocturnal oximetry for screening patients with suspected sleep apnoea syndrome. Sleep & Breathing. 2012; 16(2):419-425

448. Pradhan PS, Gliklich RE, Winkelman J. Screening for obstructive sleep apnea in patients presenting for snoring surgery. Laryngoscope. 1996; 106(11):1393-1397

449. Prasad KT, Sehgal IS, Agarwal R, Nath Aggarwal A, Behera D, Dhooria S. Assessing the likelihood of obstructive sleep apnea: A comparison of nine screening questionnaires. Sleep & Breathing. 2017; 21(4):909-917

450. Prikladnicki A, Martinez D, Brunetto MG, Fiori CZ, Lenz M, Gomes E. Diagnostic performance of cheeks appearance in sleep apnea. Cranio. 2018; 36(4):214-221

451. Quaranta VN, Dragonieri S, Carratu P, Falcone VA, Carucci E, Ranieri T et al. A new approach for the assessment of sleepiness and predictivity of obstructive sleep apnea in drivers: A pilot study. Lung India. 2016; 33(1):14-19

452. Quintana-Gallego E, Villa-Gil M, Carmona-Bernal C, Botebol-Benhamou G, Martinez-Martinez A, Sanchez-Armengol A et al. Home respiratory polygraphy for diagnosis of sleep-disordered breathing in heart failure. European Respiratory Journal. 2004; 24(3):443-448

453. Rajeswari J, Jagannath M. Screening of obstructive sleep apnea in an urban population in south India. Obesity Medicine. 2020; 18:100220

454. Randerath WJ, Treml M, Priegnitz C, Stieglitz S, Hagmeyer L, Morgenstern C. Evaluation of a noninvasive algorithm for differentiation of obstructive and central hypopneas. Sleep. 2013; 36(3):363-368

455. Rashid NH, Zaghi S, Scapuccin M, Camacho M, Certal V, Capasso R. The value of oxygen desaturation index for diagnosing obstructive sleep apnea: A systematic review. Laryngoscope. 2020; https://dx.doi.org/10.1002/lary.28663

456. Rathnayake SI, Wood IA, Abeyratne UR, Hukins C. Nonlinear features for single-channel diagnosis of sleep-disordered breathing diseases. IEEE Transactions on Biomedical Engineering. 2010; 57(8):1973-1981

457. Rauhala E, Virkkala J, Himanen SL. Periodic limb movement screening as an additional feature of Emfit sensor in sleep-disordered breathing studies. Journal of Neuroscience Methods. 2009; 178(1):157-161

458. Rauscher H, Popp W, Zwick H. Model for investigating snorers with suspected sleep apnoea. Thorax. 1993; 48(3):275-279

459. Ravelo-Garcia AG, Saavedra-Santana P, Julia-Serda G, Navarro-Mesa JL, Navarro-Esteva J, Alvarez-Lopez X et al. Symbolic dynamics marker of heart rate variability combined with clinical variables enhance obstructive sleep apnea screening. Chaos. 2014; 24(2):024404

460. Raymond B, Cayton RM, Chappell MJ. Combined index of heart rate variability and oximetry in screening for the sleep apnoea/hypopnoea syndrome. Journal of Sleep Research. 2003; 12(1):53-61

461. Rebelo-Marques A, Vicente C, Valentim B, Agostinho M, Pereira R, Teixeira MF et al. STOP-Bang questionnaire: The validation of a Portuguese version as a screening tool for obstructive sleep apnea (OSA) in primary care. Sleep & Breathing. 2018; 22(3):757-765

462. Reda M, Gibson GJ, Wilson JA. Pharyngoesophageal pressure monitoring in sleep apnea syndrome. Otolaryngology - Head and Neck Surgery. 2001; 125(4):324-331

463. Rees K, Wraith PK, Berthon-Jones M, Douglas NJ. Detection of apnoeas, hypopnoeas and arousals by the AutoSet in the sleep apnoea/hypopnoea syndrome. European Respiratory Journal. 1998; 12(4):764-769

464. Reichert JA, Bloch DA, Cundiff E, Votteri BA. Comparison of the NovaSom QSG, a new sleep apnea home-diagnostic system, and polysomnography. Sleep Medicine. 2003; 4(3):213-218

465. Reis R, Teixeira F, Martins V, Sousa L, Batata L, Santos C et al. Validation of a Portuguese version of the STOP-Bang questionnaire as a screening tool for obstructive sleep apnea: Analysis in a sleep clinic. Revista Portuguesa de Pneumologia. 2015; 21(2):61-68

466. Reisch S, Daniuk J, Steltner H, Ruhle KH, Timmer J, Guttmann J. Detection of sleep apnea with the forced oscillation technique compared to three standard polysomnographic signals. Respiration. 2000; 67(5):518-525

467. Reuven H, Schweitzer E, Tarasiuk A. A cost-effectiveness analysis of alternative at-home or in-laboratory technologies for the diagnosis of obstructive sleep apnea syndrome. Medical Decision Making. 2001; 21(6):451-458

468. Roche F, Celle S, Pichot V, Barthelemy JC, Sforza E. Analysis of the interbeat interval increment to detect obstructive sleep apnoea/hypopnoea. European Respiratory Journal. 2007; 29(6):1206-1211

469. Roche F, Duverney D, Court-Fortune I, Pichot V, Costes F, Lacour JR et al. Cardiac interbeat interval increment for the identification of obstructive sleep apnea. Pacing and Clinical Electrophysiology. 2002; 25(8):1192-1199

470. Roche F, Gaspoz JM, Court-Fortune I, Minini P, Pichot V, Duverney D et al. Screening of obstructive sleep apnea syndrome by heart rate variability analysis. Circulation. 1999; 100(13):1411-1415

471. Roche F, Sforza E, Duverney D, Borderies JR, Pichot V, Bigaignon O et al. Heart rate increment: An electrocardiological approach for the early detection of obstructive sleep apnoea/hypopnoea syndrome. Clinical Science. 2004; 107(1):105-110

472. Roche N, Herer B, Roig C, Huchon G. Prospective testing of two models based on clinical and oximetric variables for prediction of obstructive sleep apnea. Chest. 2002; 121(3):747-752

473. Rodrigues Filho JC, Neves DD, Velasque L, Maranhao AA, de Araujo-Melo MH. Diagnostic performance of nocturnal oximetry in the detection of obstructive sleep apnea syndrome: a Brazilian study. Sleep and Breathing. 2020; http://dx.doi.org/10.1007/s11325-019-02000-4

474. Rodsutti J, Hensley M, Thakkinstian A, D'Este C, Attia J. A clinical decision rule to prioritize polysomnography in patients with suspected sleep apnea. Sleep. 2004; 27(4):694-699

475. Rofail LM, Wong KK, Unger G, Marks GB, Grunstein RR. Comparison between a single-channel nasal airflow device and oximetry for the diagnosis of obstructive sleep apnea. Sleep. 2010; 33(8):1106-1114

476. Rofail LM, Wong KK, Unger G, Marks GB, Grunstein RR. The role of single-channel nasal airflow pressure transducer in the diagnosis of OSA in the sleep laboratory. Journal of Clinical Sleep Medicine. 2010; 6(4):349-356

477. Rofail LM, Wong KK, Unger G, Marks GB, Grunstein RR. The utility of single-channel nasal airflow pressure transducer in the diagnosis of OSA at home. Sleep. 2010; 33(8):1097-1105

478. Rolon RE, Larrateguy LD, Di Persia LE, Spies RD, Rufiner HL. Discriminative methods based on sparse representations of pulse oximetry signals for sleep apnea-hypopnea detection. Biomedical Signal Processing and Control. 2017; 33:358-367

479. Romano S, Salvaggio A, Lo Bue A, Marrone O, Insalaco G. A negative expiratory pressure test during wakefulness for evaluating the risk of obstructive sleep apnea in patients referred for sleep studies. Clinics (Sao Paulo, Brazil). 2011; 66(11):1887-1894

480. Romem A, Romem A, Koldobskiy D, Scharf SM. Diagnosis of obstructive sleep apnea using pulse oximeter derived photoplethysmographic signals. Journal of Clinical Sleep Medicine. 2014; 10(3):285-290

481. Romero-Lopez Z, Ochoa-Vazquez MD, Mata-Marin JA, Ochoa-Jimenez LG, Rico-Mendez FG. Development and validation of a questionnaire to identify patients with sleep apnea in Mexican population: Mexican questionnaire to identify sleep apnea. Sleep & Breathing. 2011; 15(1):113-119

482. Rosen CL, Auckley D, Benca R, Foldvary-Schaefer N, Iber C, Kapur V et al. A multisite randomized trial of portable sleep studies and positive airway pressure autotitration versus laboratory-based polysomnography for the diagnosis and treatment of obstructive sleep apnea: The HomePAP study. Sleep. 2012; 35(6):757-767

483. Rosen IM, Kirsch DB, Carden KA, Malhotra RK, Ramar K, Aurora RN et al. Clinical use of a home sleep apnea test: An updated American Academy of Sleep Medicine position statement. Journal of Clinical Sleep Medicine. 2018; 14(12):2075-2077

484. Rosenthal LD, Dolan DC. The Epworth sleepiness scale in the identification of obstructive sleep apnea. Journal of Nervous and Mental Disease. 2008; 196(5):429-431

485. Rosenwein T, Dafna E, Tarasiuk A, Zigel Y. Breath-by-breath detection of apneic events for OSA severity estimation using non-contact audio recordings. Conference proceedings: Annual International Conference of the IEEE Engineering in Medicine and Biology Society. 2015; 2015:7688-7691

486. Ross SD, Allen IE, Harrison KJ. Review: Screening tests are not as accurate as overnight polysomnography for the diagnosis of adult sleep apnoea. Evidence-Based Medicine. 2000; 5(2):61

487. Ross SD, Allen IE, Harrison KJ, Kvasz M, Connelly J, Sheinhait IA. Systematic review of the literature regarding the diagnosis of sleep apnea. Summary, Evidence Report/Technology Assessment: Number 1, December 1998. Rockville, MD. Agency for Health Care Policy and Research, 1998. Available from: https://www.ncbi.nlm.nih.gov/books/NBK11925/

488. Ross SD, Sheinhait IA, Harrison KJ, Kvasz M, Connelly JE, Shea SA et al. Systematic review and meta-analysis of the literature regarding the diagnosis of sleep apnea. Sleep. 2000; 23(4):519-532

489. Rowley JA, Aboussouan LS, Badr MS. The use of clinical prediction formulas in the evaluation of obstructive sleep apnea. Sleep. 2000; 23(7):929-938

490. Ryan PJ, Hilton MF, Boldy DA, Evans A, Bradbury S, Sapiano S et al. Validation of British Thoracic Society guidelines for the diagnosis of the sleep apnoea/hypopnoea syndrome: Can polysomnography be avoided? Thorax. 1995; 50(9):972-975

491. Saarelainen S, Himanen SL, Hasan J, Virkkala J, Koobi T. Whole-body impedance recording--a practical method for the diagnosis of sleep apnoea. Clinical Physiology and Functional Imaging. 2003; 23(2):110-113

492. Saha S, Kabir M, Montazeri Ghahjaverestan N, Hafezi M, Gavrilovic B, Zhu K et al. Portable diagnosis of sleep apnea with the validation of individual event detection. Sleep Medicine. 2020; 69:51-57

493. Saleh AB, Ahmad MA, Awadalla NJ. Development of Arabic version of Berlin questionnaire to identify obstructive sleep apnea at risk patients. Annals of Thoracic Medicine. 2011; 6(4):212-216

494. Sangkum L, Klair I, Limsuwat C, Bent S, Myers L, Thammasitboon S. Incorporating body-type (apple vs. pear) in STOP-BANG questionnaire improves its validity to detect OSA. Journal of Clinical Anesthesia. 2017; 41:126-131

495. Santaolalla Montoya F, Iriondo Bedialauneta JR, Aguirre Larracoechea U, Martinez Ibarguen A, Sanchez Del Rey A, Sanchez Fernandez JM. The predictive value of clinical and epidemiological parameters in the identification of patients with obstructive sleep apnoea (OSA): A clinical prediction algorithm in the evaluation of OSA. European Archives of Oto-Rhino-Laryngology. 2007; 264(6):637-643

496. Saricam E, Yalcinkaya E, Basay N. Bedside approach in the diagnosis obstructive sleep apnea using postprandial oximetry testing: A comparative study with polysomnography. Clinical Respiratory Journal. 2020; 14(1):35-39

497. Savage HO, Khushaba RN, Zaffaroni A, Colefax M, Farrugia S, Schindhelm K et al. Development and validation of a novel non-contact monitor of nocturnal respiration for identifying sleep-disordered breathing in patients with heart failure. ESC heart failure. 2016; 3(3):212-219

498. Scarlata S, Pedone C, Curcio G, Cortese L, Chiurco D, Fontana D et al. Pre-polysomnographic assessment using the Pittsburgh Sleep Quality Index questionnaire is not useful in identifying people at higher risk for obstructive sleep apnea. Journal of Medical Screening. 2013; 20(4):220-226

499. Schafer H, Ewig S, Hasper E, Luderitz B. Predictive diagnostic value of clinical assessment and nonlaboratory monitoring system recordings in patients with symptoms suggestive of obstructive sleep apnea syndrome. Respiration. 1997; 64(3):194-199

500. Scharf C, Cho YK, Bloch KE, Brunckhorst C, Duru F, Balaban K et al. Diagnosis of sleep-related breathing disorders by visual analysis of transthoracic impedance signals in pacemakers. Circulation. 2004; 110(17):2562-2567

501. Senaratna CV, Perret JL, Lowe A, Bowatte G, Abramson MJ, Thompson B et al. Detecting sleep apnoea syndrome in primary care with screening questionnaires and the Epworth sleepiness scale. Medical Journal of Australia. 2019; 211(2):65-70

502. Senn O, Brack T, Russi EW, Bloch KE. A continuous positive airway pressure trial as a novel approach to the diagnosis of the obstructive sleep apnea syndrome. Chest. 2006; 129(1):67-75

503. Sergi M, Rizzi M, Greco M, Andreoli A, Bamberga M, Castronovo C et al. Validity of diurnal sleep recording performed by an ambulatory device in the diagnosis of obstructive sleep apnoea. Respiratory Medicine. 1998; 92(2):216-220

504. Series F, Cormier Y, La Forge J. Validity of diurnal sleep recording in the diagnosis of sleep apnea syndrome. American Review of Respiratory Disease. 1991; 143(5 I):947-949

505. Series F, Marc I. Nasal pressure recording in the diagnosis of sleep apnoea hypopnoea syndrome. Thorax. 1999; 54(6):506-510

506. Series F, Marc I, Cormier Y, La Forge J. Utility of nocturnal home oximetry for case finding in patients with suspected sleep apnea hypopnea syndrome. Annals of Internal Medicine. 1993; 119(6):449-453

507. Serrano EM, Lopez-Picado A, Etxagibel A, Casi A, Cancelo L, Aguirregomoscorta JI et al. Derivation and validation of a clinical prediction rule for sleep apnoea syndrome for use in primary care. BJGP Open. 2018; 2(2):1-10

508. Sert Kuniyoshi FH, Zellmer MR, Calvin AD, Lopez-Jimenez F, Albuquerque FN, van der Walt C et al. Diagnostic accuracy of the Berlin Questionnaire in detecting sleep-disordered breathing in patients with a recent myocardial infarction. Chest. 2011; 140(5):1192-1197

509. Sforza E, Pichot V, Cervena K, Barthelemy JC, Roche F. Cardiac variability and heart-rate increment as a marker of sleep fragmentation in patients with a sleep disorder: A preliminary study. Sleep. 2007; 30(1):43-51

510. Shalaby A, Atwood C, Hansen C, Konermann M, Jamnadas P, Lee K et al. Feasibility of automated detection of advanced sleep disordered breathing utilizing an implantable pacemaker ventilation sensor. Pacing and Clinical Electrophysiology. 2006; 29(10):1036-1043

511. Shams E, Karimi D, Moussavi Z. Bispectral analysis of tracheal breath sounds for Obstructive Sleep Apnea. Conference Proceedings: Annual International Conference of the IEEE Engineering in Medicine & Biology Society. 2012; 2012:37-40

512. Shi W, Xue B, Guo S, Goh DYT, Ser W. Obstructive Sleep Apnea Detection Using Difference in Feature and Modified Minimum Distance Classifier. Conference Proceedings: Annual International Conference of the IEEE Engineering in Medicine & Biology Society. 2018; 2018:1-4

513. Shin JH, Chee YJ, Jeong DU, Park KS. Nonconstrained sleep monitoring system and algorithms using air-mattress with balancing tube method. IEEE Transactions on Information Technology in Biomedicine. 2010; 14(1):147-156

514. Shochat T, Hadas N, Kerkhofs M, Herchuelz A, Penzel T, Peter JH et al. The SleepStrip: An apnoea screener for the early detection of sleep apnoea syndrome. European Respiratory Journal. 2002; 19(1):121-126

515. Shokrollahi M, Saha S, Hadi P, Rudzicz F, Yadollahi A. Snoring sound classification from respiratory signal. Conference Proceedings: Annual International Conference of the IEEE Engineering in Medicine & Biology Society. 2016; 2016:3215-3218

516. Siegel H, Sonies BC, Graham B, McCutchen C, Hunter K, Vega-Bermudez F et al. Obstructive sleep apnea: A study by simultaneous polysomnography and ultrasonic imaging. Neurology. 2000; 54(9):1872

517. Silva GE, Vana KD, Goodwin JL, Sherrill DL, Quan SF. Identification of patients with sleep disordered breathing: Comparing the four-variable screening tool, STOP, STOP-Bang, and Epworth Sleepiness Scales. Journal of Clinical Sleep Medicine. 2011; 7(5):467-472

518. Sivam S, Yee B, Wong K, Wang D, Grunstein R, Piper A. Obesity hypoventilation syndrome: Early detection of nocturnal-only hypercapnia in an obese population. Journal of Clinical Sleep Medicine. 2018; 14(9):1477-1484

519. Skiba V, Goldstein C, Schotland H. Night-to-night variability in sleep disordered breathing and the utility of esophageal pressure monitoring in suspected obstructive sleep apnea. Journal of Clinical Sleep Medicine. 2015; 11(6):597-602

520. Skomro RP, Cotton DJ, Gjevre JA, Grover VK, McNab BD, Reid JK et al. An empirical continuous positive airway pressure trial for suspected obstructive sleep apnea. Canadian Respiratory Journal. 2007; 14(3):159-163

521. Smith D, Park J, Hay K, Hoey L, Leong G, Leong M et al. Use of a limited-channel device for obstructive sleep apnoea diagnosis in a tertiary sleep disorders centre. Internal Medicine Journal. 2020; 50(9):1109-1114

522. Sola-Soler J, Fiz JA, Morera J, Jane R. Multiclass classification of subjects with sleep apnoea-hypopnoea syndrome through snoring analysis. Medical Engineering and Physics. 2012; 34(9):1213-1220

523. Sola-Soler J, Fiz JA, Torres A, Jane R. Identification of Obstructive Sleep Apnea patients from tracheal breath sound analysis during wakefulness in polysomnographic studies. Conference Proceedings: Annual International Conference of the IEEE Engineering in Medicine & Biology Society. 2014; 2014:4232-4235

524. Sola-Soler J, Jane R, Fiz JA, Morera J. Automatic classification of subjects with and without sleep apnea through snoring analysis. Conference Proceedings: Annual International Conference of the IEEE Engineering in Medicine & Biology Society. 2007; 2007:6094-6097

525. Sommermeyer D, Zou D, Grote L, Hedner J. Detection of sleep disordered breathing and its central/obstructive character using nasal cannula and finger pulse oximeter. Journal of Clinical Sleep Medicine. 2012; 8(5):527-533

526. Song C, Liu K, Zhang X, Chen L, Xian X. An obstructive sleep apnea detection approach using a discriminative hidden Markov model from ECG Signals. IEEE Transactions on Biomedical Engineering. 2016; 63(7):1532-1542

527. Stein PK, Duntley SP, Domitrovich PP, Nishith P, Carney RM. A simple method to identify sleep apnea using Holter recordings. Journal of Cardiovascular Electrophysiology. 2003; 14(5):467-473

528. Stelmach-Mardas M, Iqbal K, Mardas M, Kostrzewska M, Piorunek T. Clinical utility of Berlin questionnaire in comparison to polysomnography in patients with obstructive sleep apnea. Advances in Experimental Medicine and Biology. 2017; 980:51-57

529. Stendardo M, Casillo V, Schito M, Ballerin L, Stomeo F, Vitali E et al. Forced expiratory volume in one second: A novel predictor of work disability in subjects with suspected obstructive sleep apnea. PloS One. 2018; 13(7):e0201045

530. Stewart SA, Penz E, Fenton M, Skomro R. Investigating cost implications of incorporating level III at-home testing into a polysomnography based sleep medicine program using administrative data. Canadian Respiratory Journal. 2017; 2017:8939461

531. Stoohs R, Guilleminault C. Investigations of an automatic screening device (MESAM) for obstructive sleep apnoea. European Respiratory Journal. 1990; 3(7):823-829

532. Stoohs R, Guilleminault C. MESAM 4: An ambulatory device for the detection of patients at risk for obstructive sleep apnea syndrome (OSAS). Chest. 1992; 101(5):1221-1227

533. Su CT, Chen KH, Chen LF, Wang PC, Hsiao YH. Prediagnosis of obstructive sleep apnea via multiclass MTS. Computational and Mathematical Methods in Medicine. 2012; 2012:212498

534. Su S, Baroody FM, Kohrman M, Suskind D. A comparison of polysomnography and a portable home sleep study in the diagnosis of obstructive sleep apnea syndrome. Otolaryngology - Head and Neck Surgery. 2004; 131(6):844-850

535. Subramanian S, Hesselbacher SE, Aguilar R, Surani SR. The NAMES assessment: A novel combined-modality screening tool for obstructive sleep apnea. Sleep & Breathing. 2011; 15(4):819-826

536. Suksakorn S, Rattanaumpawan P, Banhiran W, Cherakul N, Chotinaiwattarakul W. Reliability and validity of a Thai version of the Berlin questionnaire in patients with sleep disordered breathing. Journal of the Medical Association of Thailand. 2014; 97(Suppl 3):S46-56

537. Sun LM, Chiu HW, Chuang CY, Liu L. A prediction model based on an artificial intelligence system for moderate to severe obstructive sleep apnea. Sleep & Breathing. 2011; 15(3):317-323

538. Sun WL, Wang JL, Jia GH, Mi WJ, Liao YX, Huang YW et al. Impact of obstructive sleep apnea on pulmonary hypertension in patients with chronic obstructive pulmonary disease. Chinese Medical Journal. 2019; 132(11):1272-1282

539. Takama N, Kurabayashi M. Effectiveness of a portable device and the need for treatment of mild-to-moderate obstructive sleep-disordered breathing in patients with cardiovascular disease. Journal of Cardiology. 2010; 56(1):73-78

540. Takeda T, Nishimura Y, Satouchi M, Kamiryo H, Takenaka K, Kasai D et al. Usefulness of the oximetry test for the diagnosis of sleep apnea syndrome in Japan. American Journal of the Medical Sciences. 2006; 331(6):304-308

541. Tanaka F, Nakano H, Sudo N, Kubo C. Relationship between the body position-specific apnea-hypopnea index and subjective sleepiness. Respiration. 2009; 78(2):185-190

542. Tauman R, O'Brien LM, Barbe F, Iyer VG, Gozal D. Reciprocal interactions between spontaneous and respiratory arousals in adults with suspected sleep-disordered breathing. Sleep Medicine. 2006; 7(3):229-234

543. Teferra RA, Grant BJ, Mindel JW, Siddiqi TA, Iftikhar IH, Ajaz F et al. Cost minimization using an artificial neural network sleep apnea prediction tool for sleep studies. Annals of the American Thoracic Society. 2014; 11(7):1064-1074

544. Teklu M, Gouveia CJ, Yalamanchili A, Ghadersohi S, Price CPE, Bove M et al. Predicting obstructive sleep apnea status with the reflux symptom index in a sleep study population. Laryngoscope. 2020; http://dx.doi.org/10.1002/lary.28592

545. Teramoto S, Matsuse T, Fukuchi Y. Clinical significance of nocturnal oximeter monitoring for detection of sleep apnea syndrome in the elderly. Sleep Medicine. 2002; 3(1):67-71

546. Terjung S, Geldmacher J, Brato S, Werther S, Teschler H, Taube C et al. Classification of sleep and wake using a novel minimal-contact single-channel device. Somnologie. 2018; 22(2):144-151

547. Terjung S, Wang Y, Werther S, Zaffaroni A, Teschler H, Weinreich G. Validation of SleepMinder for sleep quality evaluation in patients with OSAS. Somnologie. 2016; 20(1):54-60

548. Thong JF, Pang KP. Clinical parameters in obstructive sleep apnea: Are there any correlations? Journal of Otolaryngology - Head & Neck Surgery. 2008; 37(6):894-900

549. Thornton AT, Singh P, Ruehland WR, Rochford PD. AASM criteria for scoring respiratory events: interaction between apnea sensor and hypopnea definition. Sleep. 2012; 35(3):425-432

550. Tian J, Liu J. Apnea detection based on time delay neural network. Conference Proceedings: Annual International Conference of the IEEE Engineering in Medicine & Biology Society. 2005; 2005:2571-2574

551. Tiihonen P, Hukkanen T, Tuomilehto H, Mervaala E, Toyras J. Evaluation of a novel ambulatory device for screening of sleep apnea. Telemedicine Journal and e-Health. 2009; 15(3):283-289

552. Ting H, Mai YT, Hsu HC, Wu HC, Tseng MH. Decision tree based diagnostic system for moderate to severe obstructive sleep apnea. Journal of Medical Systems. 2014; 38(9):94

553. To KW, Chan WC, Chan TO, Ngai J, Tung A, Ng S et al. Comparison of empirical continuous positive airway pressure (CPAP) treatment versus initial portable sleep monitoring followed by CPAP treatment for patients with suspected obstructive sleep apnoea. Internal Medicine Journal. 2012; 42(6):e107-114

554. To KW, Chan WC, Chan TO, Tung A, Ngai J, Ng S et al. Validation study of a portable monitoring device for identifying OSA in a symptomatic patient population. Respirology. 2009; 14(2):270-275

555. Tong GM, Zhang HC, Guo JH, Han F. Detection of sleep apnea-hypopnea syndrome with ECG derived respiration in Chinese population. International Journal of Clinical and Experimental Medicine. 2014; 7(5):1269-1275

556. Topor ZL, Remmers JE, Grosse J, Mosca EV, Jahromi SAZ, Zhu Y et al. Validation of a new unattended sleep apnea monitor using two methods for the identification of hypopneas. Journal of Clinical Sleep Medicine. 2020; 16(5):695-703

557. Traxdorf M, Tziridis K, Scherl C, Iro H, Haferkamp J. The Erlangen Questionnaire: a new 5-item screening tool for obstructive sleep apnea in a sleep clinic population - A prospective, double blinded study. European Review for Medical and Pharmacological Sciences. 2017; 21(16):3690-3698

558. Tsai WH, Remmers JE, Brant R, Flemons WW, Davies J, Macarthur C. A decision rule for diagnostic testing in obstructive sleep apnea. American Journal of Respiratory and Critical Care Medicine. 2003; 167(10):1427-1432

559. Tsukahara M, Sakao S, Jujo T, Sakurai T, Terada J, Kunii R et al. The accuracy and uncertainty of a sheet-type portable monitor as a screening device to identify obstructive sleep apnea-hypopnea syndrome. Internal Medicine. 2014; 53(12):1307-1313

560. Ugon A, Seroussi B, Philippe C, Ganascia JG, Garda P, Sedki K et al. Towards a wireless smart polysomnograph using symbolic fusion. Studies in Health Technology and Informatics. 2016; 221:23-27

561. Ulasli SS, Gunay E, Koyuncu T, Akar O, Halici B, Ulu S et al. Predictive value of Berlin Questionnaire and Epworth Sleepiness Scale for obstructive sleep apnea in a sleep clinic population. Clinical Respiratory Journal. 2014; 8(3):292-296

562. Unal M, Ozturk L, Kanik A. The role of oxygen saturation measurement and body mass index in distinguishing between non-apnoeic snorers and patients with obstructive sleep apnoea syndrome. Clinical Otolaryngology and Allied Sciences. 2002; 27(5):344-346

563. Ustun B, Westover MB, Rudin C, Bianchi MT. Clinical prediction models for sleep apnea: The importance of medical history over symptoms. Journal of Clinical Sleep Medicine. 2016; 12(2):161-168

564. Valipour A, Lothaller H, Rauscher H, Zwick H, Burghuber OC, Lavie P. Gender-related differences in symptoms of patients with suspected breathing disorders in sleep: A clinical population study using the sleep disorders questionnaire. Sleep. 2007; 30(3):312-319

565. Van Brunt DL, Lichstein KL, Noe SL, Aguillard RN, Lester KW. Intensity pattern of snoring sounds as a predictor for sleep-disordered breathing. Sleep. 1997; 20(12):1151-1156

566. Van Meerhaeghe A, Delpire P, Stenuit P, Kerkhofs M. Operating characteristics of the negative expiratory pressure technique in predicting obstructive sleep apnoea syndrome in snoring patients. Thorax. 2004; 59(10):883-888

567. Van Surell C, Lemaigre D, Leroy M, Foucher A, Hagenmuller MP, Raffestin B. Evaluation of an ambulatory device, CID 102, in the diagnosis of obstructive sleep apnoea syndrome. European Respiratory Journal. 1995; 8(5):795-800

568. Vana KD, Silva GE, Goldberg R. Predictive abilities of the STOP-Bang and Epworth Sleepiness Scale in identifying sleep clinic patients at high risk for obstructive sleep apnea. Research in Nursing and Health. 2013; 36(1):84-94

569. Varady P, Micsik T, Benedek S, Benyo Z. A novel method for the detection of apnea and hypopnea events in respiration signals. IEEE Transactions on Biomedical Engineering. 2002; 49(9):936-942

570. Vaughan L, Redline S, Stone K, Ulanski J, Rueschman M, Dailey H et al. Feasibility of self-administered sleep assessment in older women in the Women's Health Initiative (WHI). Sleep & Breathing. 2016; 20(3):1079-1091

571. Vaz AP, Drummond M, Mota PC, Severo M, Almeida J, Winck JC. Translation of Berlin Questionnaire to Portuguese language and its application in OSA identification in a sleep disordered breathing clinic. Revista Portuguesa de Pneumologia. 2011; 17(2):59-65

572. Vazquez JC, Tsai WH, Flemons WW, Masuda A, Brant R, Hajduk E et al. Automated analysis of digital oximetry in the diagnosis of obstructive sleep apnoea. Thorax. 2000; 55(4):302-307

573. Ventura C, Oliveira AS, Dias R, Teixeira J, Canhao C, Santos O et al. The role of nocturnal oximetry in obstructive sleep apnoea-hypopnoea syndrome screening. Revista Portuguesa de Pneumologia. 2007; 13(4):525-551

574. Victor Marcos J, Hornero R, Alvarez D, Del Campo F, Zamarron C, Lopez M. Single layer network classifiers to assist in the detection of obstructive sleep apnea syndrome from oximetry data. Conference Proceedings: Annual International Conference of the IEEE Engineering in Medicine & Biology Society. 2008; 2008:1651-1654

575. Virkkula P, Bachour A, Hytonen M, Malmberg H, Salmi T, Maasilta P. Patient- and bed partner-reported symptoms, smoking, and nasal resistance in sleep-disordered breathing. Chest. 2005; 128(4):2176-2182

576. Virkkula P, Silvola J, Maasilta P, Malmberg H, Salmi T. Esophageal pressure monitoring in detection of sleep-disordered breathing. Laryngoscope. 2002; 112(7 Pt 1):1264-1270

577. Wang CC, Lien HC, De Virgilio A, Huang WC, Wu MF, Liu SA et al. Airway pH monitoring in patients with suspected obstructive sleep apnoea using the Dx-pH oropharyngeal probe: Preliminary report of a prospective cohort study. Clinical Otolaryngology. 2014; 39(6):352-358

578. Ward K, Palmer L, Mukherjee S, Lee J, Cooper M, Love G et al. Evaluation of home based oximetry for investigation of Obstructive Sleep Apnoea (OSA). Sleep and Biological Rhythms. 2009; 7(Suppl 1):A43

579. Ward KL, McArdle N, James A, Bremner AP, Simpson L, Cooper MN et al. A comprehensive evaluation of a two-channel portable monitor to "rule in" obstructive sleep apnea. Journal of Clinical Sleep Medicine. 2015; 11(4):433-444

580. Ward NR, Cowie MR, Rosen SD, Roldao V, De Villa M, McDonagh TA et al. Utility of overnight pulse oximetry and heart rate variability analysis to screen for sleep-disordered breathing in chronic heart failure. Thorax. 2012; 67(11):1000-1005

581. Weinreich G, Armitstead J, Teschler H. Pattern recognition of obstructive sleep apnoea and Cheyne-Stokes respiration. Physiological Measurement. 2008; 29(8):869-878

582. Weinreich G, Terjung S, Wang Y, Werther S, Zaffaroni A, Teschler H. Validation of SleepMinder as screening device for obstructive sleep apnea. Somnologie. 2014; 18(4):238-242

583. Westerlund A, Brandt L, Harlid R, Akerstedt T, Lagerros YT. Using the Karolinska Sleep Questionnaire to identify obstructive sleep apnea syndrome in a sleep clinic population. Clinical Respiratory Journal. 2014; 8(4):444-454

584. White DP, Gibb TJ, Wall JM, Westbrook PR. Assessment of accuracy and analysis time of a novel device to monitor sleep and breathing in the home. Sleep. 1995; 18(2):115-126

585. White JE, Smithson AJ, Close PR, Drinnan MJ, Prichard AJ, Gibson GJ. The use of sound recording and oxygen saturation in screening snorers for obstructive sleep apnoea. Clinical Otolaryngology and Allied Sciences. 1994; 19(3):218-221

586. Whitelaw WA, Brant RF, Flemons WW. Clinical usefulness of home oximetry compared with polysomnography for assessment of sleep apnea. American Journal of Respiratory and Critical Care Medicine. 2005; 171(2):188-193

587. Wieczorek T, Lorenc M, Martynowicz H, Piotrowski P, Mazur G, Rymaszewska J. Parasomnias and obstructive sleep apnea syndrome: In search for a parasomnia evaluating tool appropriate for osas screening. Family Medicine and Primary Care Review. 2018; 20(2):176-181

588. Williams AJ, Yu G, Santiago S, Stein M. Screening for sleep apnea using pulse oximetry and a clinical score. Chest. 1991; 100(3):631-635

589. Williams R, Williams M, Stanton MP, Spence CD. Implementation of an obstructive sleep apnea screening program at an overseas military hospital. AANA Journal. 2017; 85(1):42-48

590. Wiltshire N, Kendrick AH, Catterall JR. Home oximetry studies for diagnosis of sleep apnea/hypopnea syndrome: Limitation of memory storage capabilities. Chest. 2001; 120(2):384-389

591. Wong KK, Jankelson D, Reid A, Unger G, Dungan G, Hedner JA et al. Diagnostic test evaluation of a nasal flow monitor for obstructive sleep apnea detection in sleep apnea research. Behavior Research Methods. 2008; 40(1):360-366

592. Wu MF, Huang WC, Juang CF, Chang KM, Wen CY, Chen YH et al. A new method for self-estimation of the severity of obstructive sleep apnea using easily available measurements and neural fuzzy evaluation system. IEEE Journal of Biomedical & Health Informatics. 2017; 21(6):1524-1532

593. Wu Q, Xie L, Li W, Xiang G, Hu W, Jiang H et al. Pulmonary function influences the performance of berlin questionnaire, modified berlin questionnaire, and stop-bang score for screening obstructive sleep apnea in subjects with chronic obstructive pulmonary disease. International Journal of COPD. 2020; 15:1207-1216

594. Xie B, Minn H. Real-time sleep apnea detection by classifier combination. IEEE Transactions on Information Technology in Biomedicine. 2012; 16(3):469-477

595. Xie L, Wu Q, Hu W, Li W, Xiang G, Hao S et al. Performance of brief ICF-sleep disorders and obesity core set in obstructive sleep apnea patients. Respiratory Research. 2020; 21(1):156

596. Xiong M, Hu W, Dong M, Wang M, Chen J, Xiong H et al. The screening value of ESS, SACS, BQ, and SBQ on obstructive sleep apnea in patients with chronic obstructive pulmonary disease. International Journal of COPD. 2019; 14:2497-2505

597. Xu L, Han F, Keenan BT, Kneeland-Szanto E, Yan H, Dong X et al. Validation of the NOX-T3 portable monitor for diagnosis of obstructive sleep apnea in chinese adults. Journal of Clinical Sleep Medicine. 2017; 13(5):675-683

598. Yaddanapudi SS, Pineda MC, Boorman DW, Bryne RE, Hing KL, Sharma S. High-Resolution Pulse Oximetry (HRPO): A cost-effective tool in screening for obstructive sleep apnea (OSA) in acute stroke and predicting outcome. Journal of Stroke and Cerebrovascular Diseases. 2018; 27(11):2986-2992

599. Yagi H, Nakata S, Tsuge H, Yasuma F, Noda A, Morinaga M et al. Significance of a screening device (Apnomonitor 5) for sleep apnea syndrome. Auris, Nasus, Larynx. 2009; 36(2):176-180

600. Yalamanchali S, Farajian V, Hamilton C, Pott TR, Samuelson CG, Friedman M. Diagnosis of obstructive sleep apnea by peripheral arterial tonometry: Meta-analysis. JAMA Otolaryngology-- Head & Neck Surgery. 2013; 139(12):1343-1350

601. Yamaguchi Y, Taketa Y. Clinical evaluation of the SleepStrip, a screening device for the easy diagnosis of sleep apnea-hypopnea syndrome. Sleep and Biological Rhythms. 2007; 5(3):215-217

602. Yamashiro Y, Kryger MH. Nocturnal oximetry: Is it a screening tool for sleep disorders? Sleep. 1995; 18(3):167-171

603. Yang GG, Yang MC, Chung CY, Chen YT, Chang ET. Respiratory-inductive-plethysmography-derived flow can be a useful clinical tool to detect patients with obstructive sleep apnea syndrome. Journal of the Formosan Medical Association. 2011; 110(10):642-645

604. Yang Y, Chung F. A screening tool of obstructive sleep apnea: STOP-bang questionnaire. Sleep Medicine Clinics. 2013; 8(1):65-72

605. Yin M, Miyazaki S, Ishikawa K. Evaluation of type 3 portable monitoring in unattended home setting for suspected sleep apnea: factors that may affect its accuracy. Otolaryngology - Head and Neck Surgery. 2006; 134(2):204-209

606. Yin M, Miyazaki S, Itasaka Y, Shibata Y, Abe T, Miyoshi A et al. A preliminary study on application of portable monitoring for diagnosis of obstructive sleep apnea. Auris, Nasus, Larynx. 2005; 32(2):151-156

607. Yousif M, Hussein HA. Obesity hypoventilation syndrome: What is beyond arterial blood gases? Egyptian Journal of Chest Diseases and Tuberculosis. 2020; 69(2):434-441

608. Yuceege M, Firat H, Altintas N, Mutlu M, Ardic S. The utility of neck/thyromental ratio in defining low-risk patients with obstructive sleep apnea in sleep clinics. European Archives of Oto-Rhino-Laryngology. 2014; 271(9):2575-2581

609. Yuceege M, Firat H, Sever O, Demir A, Ardic S. The effect of adding gender item to Berlin Questionnaire in determining obstructive sleep apnea in sleep clinics. Annals of Thoracic Medicine. 2015; 10(1):25-28

610. Yunus A, Seet W, Mohamad Adam B, Haniff J. Validation of the Malay version of Berlin questionaire to identify Malaysian patients for obstructive sleep apnea. Malaysian Family Physician. 2013; 8(1):5-11

611. Zaffaroni A, de Chazal P, Heneghan C, Boyle P, Mppm PR, McNicholas WT. SleepMinder: an innovative contact-free device for the estimation of the apnoea-hypopnoea index. Conference Proceedings: Annual International Conference of the IEEE Engineering in Medicine & Biology Society. 2009; 2009:7091-7094

612. Zaffaroni A, Kent B, O'Hare E, Heneghan C, Boyle P, O'Connell G et al. Assessment of sleep-disordered breathing using a non-contact bio-motion sensor. Journal of Sleep Research. 2013; 22(2):231-236

613. Zamarron C, Gude F, Barcala J, Rodriguez JR, Romero PV. Utility of oxygen saturation and heart rate spectral analysis obtained from pulse oximetric recordings in the diagnosis of sleep apnea syndrome. Chest. 2003; 123(5):1567-1576

614. Zamarron C, Hornero R, del Campo F, Abasolo D, Alvarez D. Heart rate regularity analysis obtained from pulse oximetric recordings in the diagnosis of obstructive sleep apnea. Sleep & Breathing. 2006; 10(2):83-89

615. Zamarron C, Romero PV, Gude F, Amaro A, Rodriguez JR. Screening of obstructive sleep apnoea: heart rate spectral analysis of nocturnal pulse oximetric recording. Respiratory Medicine. 2001; 95(9):759-765

616. Zamarron C, Romero PV, Rodriguez JR, Gude F. Oximetry spectral analysis in the diagnosis of obstructive sleep apnoea. Clinical Science. 1999; 97(4):467-473

617. Zarei A, Mohammadzadeh Asl B. Automatic detection of obstructive sleep apnea using wavelet transform and entropy based features from Single-Lead ECG Signal. IEEE Journal of Biomedical & Health Informatics. 2018; 23(3):1011 - 1021

618. Zhang JN, Peng B, Zhao TT, Xiang M, Fu W, Peng Y. Modification of the Epworth Sleepiness Scale in central China. Quality of Life Research. 2011; 20(10):1721-1726

619. Zhang S, Qing S, Liu H, Zhang N. Effect of HCO-3 level on the accuracy of NoSAS screening for obstructive sleep apnea hypopnea syndrome. National Medical Journal of China. 2018; 98(32):2564-2568

620. Zhou Y, Shu D, Xu H, Qiu Y, Zhou P, Ruan W et al. Validation of novel automatic ultra-wideband radar for sleep apnea detection. Journal of Thoracic Disease. 2020; 12(4):1286-1295

621. Zhu J, Zhao Z, Nie Q, Wang Y, Fu Z, Guo X et al. Effect of lung function on the apnea-hypopnea index in patients with overlap syndrome: a multicenter cross-sectional study. Sleep and Breathing. 2020; 24:1059–1066

622. Zou J, Guan J, Yi H, Meng L, Xiong Y, Tang X et al. An effective model for screening obstructive sleep apnea: a large-scale diagnostic study. PloS One. 2013; 8(12):e80704

623. Zou J, Meng L, Liu Y, Xu X, Liu S, Guan J et al. Evaluation of a 2-channel portable device and a predictive model to screen for obstructive sleep apnea in a laboratory environment. Respiratory Care. 2015; 60(3):356-362

624. Zucconi M, Ferini-Strambi L, Castronovo V, Oldani A, Smirne S. An unattended device for sleep-related breathing disorders: Validation study in suspected obstructive sleep apnoea syndrome. European Respiratory Journal. 1996; 9(6):1251-1256

625. Zywietz CW, Von Einem V, Widiger B, Joseph G. ECG analysis for sleep apnea detection. Methods of Information in Medicine. 2004; 43(1):56-59

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Appendices

Appendix A: Review protocols

Table 20: Review protocol diagnosis of obstructive sleep apnoea/hypopnoea syndrome, obesity hypoventilation syndrome and COPD-OSAHS overlap syndrome

Field	Content
PROSPERO registration number	Not registered
Review title	Diagnostic tests
Review question	What are the most clinically and cost effective diagnostic strategies for obstructive sleep apnoea/hypopnea syndrome, obesity hypoventilation syndrome and COPD-OSAHS overlap syndrome, including home- and hospital-based studies, and investigations such as oximetry, capnography, respiratory polygraphy and polysomnography?
Objective	To determine what are the most clinically and cost effective diagnostic strategies for obstructive sleep apnoea/hypopnea syndrome, obesity hypoventilation syndrome and COPD-OSAHS overlap syndrome.
Searches	The following databases (from inception) will be searched: • Cochrane Central Register of Controlled Trials (CENTRAL) • Cochrane Database of Systematic Reviews (CDSR) • Embase • MEDLINE • Epistemonikos Searches will be restricted by: • English language studies The searches may be re-run 6 weeks before the final committee meeting and further studies retrieved for inclusion if relevant. The full search strategies will be published in the final review.
Condition or domain being studied	Obstructive sleep apnoea/hypopnoea syndrome is the most common form of sleep disordered breathing. The guideline will also cover obesity hypoventilation syndrome and COPD-OSAHS overlap syndrome overlap syndrome (the coexistence of obstructive sleep apnoea/hypopnoea syndrome and chronic obstructive pulmonary disease).
Population	Inclusion: People in whom OSAHS/OHS/ COPD-OSAHS overlap syndrome is suspected based on symptoms or co-existing conditions Population will be stratified by: Suspicion of OSAHS vs OHS vs COPD-OSAHS overlap syndrome

Intervention/Exposure/Test	Index tests strategies will include any one or more of the below: • Home oximetry • Home oxycapnography (OHS only) • Home respiratory polygraphy • Venous bicarbonate (OHS only) • Hospital oxycapnography (OHS only) • Hospital respiratory polygraphy For test and treat studies, negative test results must receive no OSAHS/OHS/ COPD-OSAHS overlap syndrome treatment and positive test results should receive some form of OSAHS/OHS/ COPD-OSAHS overlap syndrome (including CPAP, surgery, mandibular devices – directness to be assessed against results of intervention reviews elsewhere in the guideline).
Comparator/Reference standard/Confounding factors	**Accuracy** For diagnosis of OSAHS reference standard will be AHI/RDI/ODI >5 by hospital polysomnography For diagnosis of OHS reference standard will be hypercapnia on arterial/capillary blood gases **Test and treat** Any testing strategy compared with any other including the reference standards listed above
Types of study to be included	Single gate cross-sectional study designs will be included in the accuracy review. Two gate study designs will be excluded from the accuracy review RCTs will be prioritised for test and treat comparisons, if insufficient RCTs are found, non-randomised studies will be considered if they adjust for key confounders (age, BMI, co-existing conditions).
Other exclusion criteria	None
Context	NA
Primary outcomes (critical outcomes)	**Accuracy outcomes**: • Sensitivity • Specificity • PPV • NPV **Test and treat outcomes**: • Mortality (dichotomous) • Generic or disease specific quality of life (continuous)
Secondary outcomes	**Test and treat outcomes**: • Sleepiness scores (continuous, e.g. Epworth)

(important outcomes)	• Apnoea-Hypopnoea index or respiratory disturbance index (continuous)
	• Oxygen desaturation index (continuous)
	• Healthcare resource use (rates/dichotomous)
	• Impact on co-existing conditions:
	  ○ HbA1c for diabetes (continuous)
	  ○ Cardiovascular events for cardiovascular disease (dichotomous)
	  ○ Systolic blood pressure for hypertension (continuous)	

Data extraction (selection and coding)	EndNote will be used for reference management, sifting, citations and bibliographies. All references identified by the searches and from other sources will be screened for inclusion. 10% of the abstracts will be reviewed by two reviewers, with any disagreements resolved by discussion or, if necessary, a third independent reviewer. The full text of potentially eligible studies will be retrieved and will be assessed in line with the criteria outlined above. A standardised form will be used to extract data from studies (see Developing NICE guidelines: the manual section 6.4).	
Risk of bias (quality) assessment	Risk of bias will be assessed using the appropriate checklist as described in Developing NICE guidelines: the manual. • Diagnostic test accuracy studies: QUADAS-2 • Standard RCT checklists will be used to critically appraise individual studies for the test and treat evidence. 10% of all evidence reviews are quality assured by a senior research fellow. This includes checking: • papers were included /excluded appropriately • a sample of the data extractions • correct methods are used to synthesise data • a sample of the risk of bias assessments Disagreements between the review authors over the risk of bias in particular studies will be resolved by discussion, with involvement of a third review author where necessary.	
Strategy for data synthesis	RevMan will be used for production of paired forest plots and pairwise meta-analysis of test and treat outcomes. WinBUGS will be used for meta-analysis of diagnostic accuracy studies. GRADEpro will be used to assess the quality of evidence for each test and treat outcome. **For test and treat studies** Heterogeneity between the studies in effect measures will be assessed using the I^2 statistic and visually inspected. An I^2 value greater than 50% will be considered indicative of substantial heterogeneity. Sensitivity analyses will be conducted based on pre-specified subgroups using stratified meta-analysis to explore the heterogeneity in effect estimates. If this does not explain the heterogeneity, the results will be presented pooled using random-effects.	
Analysis of sub-groups	Subgroups that will be investigated if heterogeneity is present: • BMI – obese vs non-obese • Co-existing conditions vs no co-existing conditions	
	☐	Intervention

Type and method of review	☒	Diagnostic
	☐	Prognostic
	☐	Qualitative
	☐	Epidemiologic
	☐	Service Delivery
	☐	Other (please specify)
Language	English	
Country	England	
Anticipated or actual start date	NA	
Anticipated completion date	NA	
Named contact	5a. Named contact National Guideline Centre 5b Named contact e-mail SleepApnoHypo@nice.org.uk 5e Organisational affiliation of the review National Institute for Health and Care Excellence (NICE) and the National Guideline Centre	
Review team members	From the National Guideline Centre: Carlos Sharpin, Guideline lead Sharangini Rajesh, Senior systematic reviewer Audrius Stonkus, Systematic reviewer Emtiyaz Chowdhury (until January 2020), Health economist David Wonderling, Head of health economics Agnes Cuyas, Information specialist (till December 2019) Jill Cobb, , Information specialist	
Funding sources/sponsor	This systematic review is being completed by the National Guideline Centre which receives funding from NICE.	
Conflicts of interest	All guideline committee members and anyone who has direct input into NICE guidelines (including the evidence review team and expert witnesses) must declare any potential conflicts of interest in line with NICE's code of practice for declaring and dealing with conflicts of interest. Any relevant interests, or changes to interests, will also be declared publicly at the start of each guideline committee meeting. Before each meeting, any potential conflicts of interest will be considered by the guideline committee Chair and a senior member of the development team. Any decisions to exclude a person from all or part of a meeting will be documented. Any changes to a member's declaration of interests will be recorded in the minutes of the meeting. Declarations of interests will be published with the final guideline.	

Collaborators	Development of this systematic review will be overseen by an advisory committee who will use the review to inform the development of evidence-based recommendations in line with section 3 of Developing NICE guidelines: the manual. Members of the guideline committee are available on the NICE website: https://www.nice.org.uk/guidance/indevelopment/gid-ng10098
Other registration details	NA – not registered
Reference/URL for published protocol	NA – not registered
Dissemination plans	NICE may use a range of different methods to raise awareness of the guideline. These include standard approaches such as: • notifying registered stakeholders of publication • publicising the guideline through NICE's newsletter and alerts • issuing a press release or briefing as appropriate, posting news articles on the NICE website, using social media channels, and publicising the guideline within NICE.
Keywords	-
Details of existing review of same topic by same authors	NA
Additional information	-
Details of final publication	www.nice.org.uk

Table 21: Health economic review protocol

Review question	All questions – health economic evidence
Objectives	To identify health economic studies relevant to any of the review questions.
Search criteria	• Populations, interventions and comparators must be as specified in the clinical review protocol above. • Studies must be of a relevant health economic study design (cost–utility analysis, cost-effectiveness analysis, cost–benefit analysis, cost–consequences analysis, comparative cost analysis). • Studies must not be a letter, editorial or commentary, or a review of health economic evaluations. (Recent reviews will be ordered although not reviewed. The bibliographies will be checked for relevant studies, which will then be ordered.) • Unpublished reports will not be considered unless submitted as part of a call for evidence. • Studies must be in English.
Search strategy	A health economic study search will be undertaken using population-specific terms and a health economic study filter – see appendix B below.
Review strategy	Studies not meeting any of the search criteria above will be excluded. Studies published before 2003, abstract-only studies and studies from non-OECD countries or the USA will also be excluded.

Each remaining study will be assessed for applicability and methodological limitations using the NICE economic evaluation checklist which can be found in appendix H of Developing NICE guidelines: the manual (2014).[360]

Inclusion and exclusion criteria

- If a study is rated as both 'Directly applicable' and with 'Minor limitations' then it will be included in the guideline. A health economic evidence table will be completed and it will be included in the health economic evidence profile.
- If a study is rated as either 'Not applicable' or with 'Very serious limitations' then it will usually be excluded from the guideline. If it is excluded, then a health economic evidence table will not be completed and it will not be included in the health economic evidence profile.
- If a study is rated as 'Partially applicable', with 'Potentially serious limitations' or both then there is discretion over whether it should be included.

Where there is discretion

The health economist will make a decision based on the relative applicability and quality of the available evidence for that question, in discussion with the guideline committee if required. The ultimate aim is to include health economic studies that are helpful for decision-making in the context of the guideline and the current NHS setting. If several studies are considered of sufficiently high applicability and methodological quality that they could all be included, then the health economist, in discussion with the committee if required, may decide to include only the most applicable studies and to selectively exclude the remaining studies. All studies excluded on the basis of applicability or methodological limitations will be listed with explanation in the excluded health economic studies appendix below.

The health economist will be guided by the following hierarchies.

Setting:

- UK NHS (most applicable).
- OECD countries with predominantly public health insurance systems (for example, France, Germany, Sweden).
- OECD countries with predominantly private health insurance systems (for example, Switzerland).
- Studies set in non-OECD countries or in the USA will be excluded before being assessed for applicability and methodological limitations.

Health economic study type:

- Cost–utility analysis (most applicable).
- Other type of full economic evaluation (cost–benefit analysis, cost-effectiveness analysis, cost–consequences analysis).
- Comparative cost analysis.
- Non-comparative cost analyses including cost-of-illness studies will be excluded before being assessed for applicability and methodological limitations.

Year of analysis:

- The more recent the study, the more applicable it will be.
- Studies published in 2003 or later but that depend on unit costs and resource data entirely or predominantly from before 2003 will be rated as 'Not applicable'.
- Studies published before 2003 will be excluded before being assessed for applicability and methodological limitations.

Quality and relevance of effectiveness data used in the health economic analysis:

- The more closely the clinical effectiveness data used in the health economic analysis match with the outcomes of the studies included in the clinical review the more useful the analysis will be for decision-making in the guideline.

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Appendix B: Literature search strategies

Sleep Apnoea search strategy 3 diagnostic tests/assessment

This literature search strategy was used for the following reviews;

- What are the most clinically and cost effective diagnostic strategies for obstructive sleep apnoea/hypopnea syndrome, obesity hypoventilation syndrome and COPD-OSAHS overlap syndrome, including home- and hospital-based studies, and investigations such as oximetry, capnography, respiratory polygraphy and polysomnography?

The literature searches for this review are detailed below and complied with the methodology outlined in Developing NICE guidelines: the manual.[360]

For more information, please see the Methods Report published as part of the accompanying documents for this guideline.

B.1 Clinical search literature search strategy

Searches were constructed using a PICO framework where population (P) terms were combined with Intervention (I) and in some cases Comparison (C) terms. Outcomes (O) are rarely used in search strategies for interventions as these concepts may not be well described in title, abstract or indexes and therefore difficult to retrieve. Search filters were applied to the search where appropriate.

Table 22: Database date parameters and filters used

Database	Dates searched	Search filter used
Medline (OVID)	1946 – 6 July 2020	Exclusions Randomised controlled trials Systematic review studies Observational studies Diagnostic tests studies
Embase (OVID)	1974 – 6 July 2020	Exclusions Randomised controlled trials Systematic review studies Observational studies Diagnostic tests studies
The Cochrane Library (Wiley)	Cochrane Reviews to 2020 Issue 7 of 12 CENTRAL to 2020 Issue 7 of 12	None
Epistemonikos (Epistemonikos Foundation)	Inception – 29 November 2018	None

Medline (Ovid) search terms

1.	exp Sleep Apnea Syndromes/
2.	(sleep* adj4 (apn?ea* or hypopn?ea*)).ti,ab.
3.	(sleep* adj4 disorder* adj4 breath*).ti,ab.
4.	(OSAHS or OSA or OSAS).ti,ab.

5.	(obes* adj3 hypoventil*).ti,ab.
6.	pickwick*.ti,ab.
7.	or/1-6
8.	letter/
9.	editorial/
10.	news/
11.	exp historical article/
12.	Anecdotes as Topic/
13.	comment/
14.	case report/
15.	(letter or comment*).ti.
16.	or/8-15
17.	randomized controlled trial/ or random*.ti,ab.
18.	16 not 17
19.	animals/ not humans/
20.	exp Animals, Laboratory/
21.	exp Animal Experimentation/
22.	exp Models, Animal/
23.	exp Rodentia/
24.	(rat or rats or mouse or mice).ti.
25.	or/18-24
26.	7 not 25
27.	limit 26 to English language
28.	(exp child/ or exp pediatrics/ or exp infant/) not (exp adolescent/ or exp adult/ or exp middle age/ or exp aged/)
29.	27 not 28
30.	(Epworth or ESS or ESS-CHAD).ti,ab.
31.	(STOP-bang or stopbang or "snoring tired observed pressure").ti,ab.
32.	((sleep* or Berlin or STOP*) adj3 (questionnair* or questionair*)).ti,ab.
33.	((score* or scoring or stratif* or assess*) adj3 (system* or schem*)).ti,ab.
34.	exp Oximetry/
35.	(oxymet* or oximet*).ti,ab.
36.	Capnography/
37.	capnogra*.ti,ab.
38.	(oxi-capnogra* or oxicapnogra* or oxy-capnogra* or oxycapnogra*).ti,ab.
39.	POLYSOMNOGRAPHY/
40.	(polysomnogra* or PSG).ti,ab.
41.	(polygraph* or HRP).ti,ab.
42.	ACTIGRAPHY/
43.	actigraph.ti,ab.
44.	(venous adj3 bicarbonat*).ti,ab.
45.	or/30-44
46.	29 and 45
47.	randomized controlled trial.pt.
48.	controlled clinical trial.pt.

49.	randomi#ed.ti,ab.
50.	placebo.ab.
51.	randomly.ti,ab.
52.	Clinical Trials as topic.sh.
53.	trial.ti.
54.	or/47-53
55.	Meta-Analysis/
56.	exp Meta-Analysis as Topic/
57.	(meta analy* or metanaly* or metaanaly* or meta regression).ti,ab.
58.	((systematic* or evidence*) adj3 (review* or overview*)).ti,ab.
59.	(reference list* or bibliograph* or hand search* or manual search* or relevant journals).ab.
60.	(search strategy or search criteria or systematic search or study selection or data extraction).ab.
61.	(search* adj4 literature).ab.
62.	(medline or pubmed or cochrane or embase or psychlit or psyclit or psychinfo or psycinfo or cinahl or science citation index or bids or cancerlit).ab.
63.	cochrane.jw.
64.	((multiple treatment* or indirect or mixed) adj2 comparison*).ti,ab.
65.	or/55-64
66.	exp "sensitivity and specificity"/
67.	(sensitivity or specificity).ti,ab.
68.	((pre test or pretest or post test) adj probability).ti,ab.
69.	(predictive value* or PPV or NPV).ti,ab.
70.	likelihood ratio*.ti,ab.
71.	likelihood function/
72.	((area under adj4 curve) or AUC).ti,ab.
73.	(receive* operat* characteristic* or receive* operat* curve* or ROC curve*).ti,ab.
74.	(diagnos* adj3 (performance* or accurac* or utilit* or value* or efficien* or effectiveness)).ti,ab.
75.	gold standard.ab.
76.	or/66-75
77.	Epidemiologic studies/
78.	Observational study/
79.	exp Cohort studies/
80.	(cohort adj (study or studies or analys* or data)).ti,ab.
81.	((follow up or observational or uncontrolled or non randomi#ed or epidemiologic*) adj (study or studies or data)).ti,ab.
82.	((longitudinal or retrospective or prospective or cross sectional) and (study or studies or review or analys* or cohort* or data)).ti,ab.
83.	Controlled Before-After Studies/
84.	Historically Controlled Study/
85.	Interrupted Time Series Analysis/
86.	(before adj2 after adj2 (study or studies or data)).ti,ab.
87.	exp case control studies/
88.	case control*.ti,ab.

89.	Cross-sectional studies/
90.	(cross sectional and (study or studies or review or analys* or cohort* or data)).ti,ab.
91.	or/77-90
92.	46 and (54 or 65 or 76 or 91)

Embase (Ovid) search terms

1.	exp Sleep Disordered Breathing/
2.	(sleep* adj4 (apn?ea* or hypopn?ea*)).ti,ab.
3.	(sleep* adj4 disorder* adj4 breath*).ti,ab.
4.	(OSAHS or OSA or OSAS).ti,ab.
5.	(obes* adj3 hypoventil*).ti,ab.
6.	pickwick*.ti,ab.
7.	or/1-6
8.	letter.pt. or letter/
9.	note.pt.
10.	editorial.pt.
11.	case report/ or case study/
12.	(letter or comment*).ti.
13.	or/8-12
14.	randomized controlled trial/ or random*.ti,ab.
15.	13 not 14
16.	animal/ not human/
17.	nonhuman/
18.	exp Animal Experiment/
19.	exp Experimental Animal/
20.	animal model/
21.	exp Rodent/
22.	(rat or rats or mouse or mice).ti.
23.	or/15-22
24.	7 not 23
25.	limit 24 to English language
26.	(exp child/ or exp pediatrics/) not (exp adult/ or exp adolescent/)
27.	25 not 26
28.	(Epworth or ESS or ESS-CHAD).ti,ab.
29.	(STOP-bang or stopbang or "snoring tired observed pressure").ti,ab.
30.	((sleep* or Berlin or STOP*) adj3 (questionnair* or questionair*)).ti,ab.
31.	((score* or scoring or stratif* or assess*) adj3 (system* or schem*)).ti,ab.
32.	oximetry/ or transcutaneous oxygen monitoring/
33.	(oxymet* or oximet*).ti,ab.
34.	capnometry/
35.	capnogra*.ti,ab.
36.	(oxi-capnogra* or oxicapnogra* or oxy-capnogra* or oxycapnogra*).ti,ab.
37.	polysomnography/
38.	(polysomnogra* or PSG).ti,ab.
39.	(polygraph* or HRP).ti,ab.

40.	actimetry/
41.	actigraph.ti,ab.
42.	(venous adj3 bicarbonat*).ti,ab.
43.	or/28-42
44.	27 and 43
45.	random*.ti,ab.
46.	factorial*.ti,ab.
47.	(crossover* or cross over*).ti,ab.
48.	((doubl* or singl*) adj blind*).ti,ab.
49.	(assign* or allocat* or volunteer* or placebo*).ti,ab.
50.	crossover procedure/
51.	single blind procedure/
52.	randomized controlled trial/
53.	double blind procedure/
54.	or/45-53
55.	systematic review/
56.	meta-analysis/
57.	(meta analy* or metanaly* or metaanaly* or meta regression).ti,ab.
58.	((systematic* or evidence*) adj3 (review* or overview*)).ti,ab.
59.	(reference list* or bibliograph* or hand search* or manual search* or relevant journals).ab.
60.	(search strategy or search criteria or systematic search or study selection or data extraction).ab.
61.	(search* adj4 literature).ab.
62.	(medline or pubmed or cochrane or embase or psychlit or psyclit or psychinfo or psycinfo or cinahl or science citation index or bids or cancerlit).ab.
63.	cochrane.jw.
64.	((multiple treatment* or indirect or mixed) adj2 comparison*).ti,ab.
65.	or/55-64
66.	exp "sensitivity and specificity"/
67.	(sensitivity or specificity).ti,ab.
68.	((pre test or pretest or post test) adj probability).ti,ab.
69.	(predictive value* or PPV or NPV).ti,ab.
70.	likelihood ratio*.ti,ab.
71.	((area under adj4 curve) or AUC).ti,ab.
72.	(receive* operat* characteristic* or receive* operat* curve* or ROC curve*).ti,ab.
73.	(diagnos* adj3 (performance* or accurac* or utilit* or value* or efficien* or effectiveness)).ti,ab.
74.	diagnostic accuracy/
75.	diagnostic test accuracy study/
76.	gold standard.ab.
77.	or/66-76
78.	Clinical study/
79.	Observational study/
80.	family study/
81.	longitudinal study/

82.	retrospective study/
83.	prospective study/
84.	cohort analysis/
85.	follow-up/
86.	cohort*.ti,ab.
87.	85 and 86
88.	(cohort adj (study or studies or analys* or data)).ti,ab.
89.	((follow up or observational or uncontrolled or non randomi#ed or epidemiologic*) adj (study or studies or data)).ti,ab.
90.	((longitudinal or retrospective or prospective or cross sectional) and (study or studies or review or analys* or cohort* or data)).ti,ab.
91.	(before adj2 after adj2 (study or studies or data)).ti,ab.
92.	or/78-84,87-91
93.	exp case control study/
94.	case control*.ti,ab.
95.	cross-sectional study/
96.	(cross sectional and (study or studies or review or analys* or cohort* or data)).ti,ab.
97.	or/92-96
98.	44 and (54 or 65 or 77 or 97)

1 **Cochrane Library (Wiley) search terms**

#1.	MeSH descriptor: [Sleep Apnea Syndromes] explode all trees
#2.	(sleep* near/4 (apn?ea* or hypopn?ea*)):ti,ab
#3.	(sleep* near/4 disorder* near/4 breath*):ti,ab
#4.	(OSAHS or OSA or OSAS):ti,ab
#5.	(obes* near/3 hypoventil*):ti,ab
#6.	pickwick*:ti,ab
#7.	(OR #1-#6)
#8.	(Epworth or ESS or ESS-CHAD):ti,ab
#9.	(STOP-bang or stopbang or "snoring tired observed pressure"):ti,ab
#10.	((sleep* or Berlin or STOP*) near/3 (questionnair* or questionair*)):ti,ab
#11.	((score* or scoring or stratif* or assess*) near/3 (system* or schem*)):ti,ab
#12.	MeSH descriptor: [Oximetry] explode all trees
#13.	(oxymet* or oximet*):ti,ab
#14.	MeSH descriptor: [Capnography] this term only
#15.	capnogra*:ti,ab
#16.	(oxi-capnogra* or oxicapnogra* or oxy-capnogra* or oxycapnogra*):ti,ab
#17.	MeSH descriptor: [Polysomnography] this term only
#18.	(polysomnogra* or PSG):ti,ab
#19.	(polygraph* or HRP):ti,ab
#20.	MeSH descriptor: [Actigraphy] this term only
#21.	actigraph:ti,ab
#22.	(venous near/3 bicarbonat*):ti,ab
#23.	(OR #8-#22)
#24.	#7 and #23

Epistemonikos search terms

1.	((title:((sleep apnea syndromes) OR (sleep* AND (apn?ea* OR hypopn?ea*)) OR (sleep* AND (apn?ea* OR hypopn?ea*)) OR (sleep* AND (disorder* OR breath*)) OR (OSAHS OR OSA OR OSAS) OR (obes* AND hypoventil*) OR pickwick*) OR abstract:((sleep apnea syndromes) OR (sleep* AND (apn?ea* OR hypopn?ea*)) OR (sleep* AND (apn?ea* OR hypopn?ea*)) OR (sleep* AND (disorder* OR breath*)) OR (OSAHS OR OSA OR OSAS) OR (obes* AND hypoventil*) OR pickwick*)))

B.2 Health Economics literature search strategy

Health economic evidence was identified by conducting a broad search relating to sleep apnoea population in NHS Economic Evaluation Database (NHS EED – this ceased to be updated after March 2015) and the Health Technology Assessment database (HTA – this ceased to be updated after March 2018) with no date restrictions. NHS EED and HTA databases are hosted by the Centre for Research and Dissemination (CRD). Additional searches were run on Medline and Embase for health economics and quality of life studies.

B.2.1 Health economic studies strategy

Table 23: Database date parameters and filters used

Database	Dates searched	Search filter used
Medline	2014 – 6 July 2020	Exclusions Health economics studies
Embase	2014 – 6 July 2020	Exclusions Health economics studies
Centre for Research and Dissemination (CRD)	HTA - Inception – 31 March 2018 NHSEED - Inception to March 2015	None

Medline (Ovid) search terms

	exp Sleep Apnea Syndromes/
1.	(sleep* adj4 (apn?ea* or hypopn?ea*)).ti,ab.
2.	(sleep* adj4 disorder* adj4 breath*).ti,ab.
3.	(OSAHS or OSA or OSAS).ti,ab.
4.	(obes* adj3 hypoventil*).ti,ab.
5.	pickwick*.ti,ab.
6.	or/1-6
7.	limit 7 to English language
8.	letter/
9.	editorial/
10.	news/
11.	exp historical article/
12.	Anecdotes as Topic/
13.	comment/
14.	case report/
15.	(letter or comment*).ti.

16.	or/9-16
17.	randomized controlled trial/ or random*.ti,ab.
18.	17 not 18
19.	animals/ not humans/
20.	exp Animals, Laboratory/
21.	exp Animal Experimentation/
22.	exp Models, Animal/
23.	exp Rodentia/
24.	(rat or rats or mouse or mice).ti.
25.	or/19-25
26.	8 not 26
27.	Economics/
28.	Value of life/
29.	exp "Costs and Cost Analysis"/
30.	exp Economics, Hospital/
31.	exp Economics, Medical/
32.	Economics, Nursing/
33.	Economics, Pharmaceutical/
34.	exp "Fees and Charges"/
35.	exp Budgets/
36.	budget*.ti,ab.
37.	cost*.ti.
38.	(economic* or pharmaco?economic*).ti.
39.	(price* or pricing*).ti,ab.
40.	(cost* adj2 (effective* or utilit* or benefit* or minimi* or unit* or estimat* or variable*)).ab.
41.	(financ* or fee or fees).ti,ab.
42.	(value adj2 (money or monetary)).ti,ab.
43.	or/28-43
44.	27 and 44

1 **Embase (Ovid) search terms**

1.	exp Sleep Disordered Breathing/
2.	(sleep* adj4 (apn?ea* or hypopn?ea*)).ti,ab.
3.	(sleep* adj4 disorder* adj4 breath*).ti,ab.
4.	(OSAHS or OSA or OSAS).ti,ab.
5.	(obes* adj3 hypoventil*).ti,ab.
6.	pickwick*.ti,ab.
7.	or/1-6
8.	limit 7 to English language
9.	letter.pt. or letter/
10.	note.pt.
11.	editorial.pt.
12.	case report/ or case study/

13.	(letter or comment*).ti.
14.	or/9-13
15.	randomized controlled trial/ or random*.ti,ab.
16.	14 not 15
17.	animal/ not human/
18.	nonhuman/
19.	exp Animal Experiment/
20.	exp Experimental Animal/
21.	animal model/
22.	exp Rodent/
23.	(rat or rats or mouse or mice).ti.
24.	or/16-23
25.	8 not 24
26.	health economics/
27.	exp economic evaluation/
28.	exp health care cost/
29.	exp fee/
30.	budget/
31.	funding/
32.	budget*.ti,ab.
33.	cost*.ti.
34.	(economic* or pharmaco?economic*).ti.
35.	(price* or pricing*).ti,ab.
36.	(cost* adj2 (effective* or utilit* or benefit* or minimi* or unit* or estimat* or variable*)).ab.
37.	(financ* or fee or fees).ti,ab.
38.	(value adj2 (money or monetary)).ti,ab.
39.	or/26-38
40.	25 and 39

NHS EED and HTA (CRD) search terms

#1.	MeSH DESCRIPTOR Sleep Apnea Syndromes EXPLODE ALL TREES
#2.	(sleep* adj4 (apn?ea* or hypopn?ea*))
#3.	(sleep* adj4 disorder* adj4 breath*)
#4.	(OSAHS or OSA or OSAS)
#5.	(obes* adj3 hypoventil*)
#6.	(pickwick*)
#7.	#1 OR #2 OR #3 OR #4 OR #5 OR #6

B.2.2 Quality of life studies strategy

Table 24: Database date parameters and filters used

Database	Dates searched	Search filter used
Medline	1946 – 26 November 2019	Exclusions Quality of life studies

Database	Dates searched	Search filter used
Embase	1974 – 26 November 2019	Exclusions Quality of life studies

1 **Medline (Ovid) search terms**

1.	exp Sleep Apnea Syndromes/
2.	(sleep* adj4 (apn?ea* or hypopn?ea*)).ti,ab.
3.	(sleep* adj4 disorder* adj4 breath*).ti,ab.
4.	(OSAHS or OSA or OSAS).ti,ab.
5.	(obes* adj3 hypoventil*).ti,ab.
6.	pickwick*.ti,ab.
7.	or/1-6
8.	limit 7 to English language
9.	letter/
10.	editorial/
11.	news/
12.	exp historical article/
13.	Anecdotes as Topic/
14.	comment/
15.	case report/
16.	(letter or comment*).ti.
17.	or/9-16
18.	randomized controlled trial/ or random*.ti,ab.
19.	17 not 18
20.	animals/ not humans/
21.	exp Animals, Laboratory/
22.	exp Animal Experimentation/
23.	exp Models, Animal/
24.	exp Rodentia/
25.	(rat or rats or mouse or mice).ti.
26.	or/19-25
27.	8 not 26
28.	quality-adjusted life years/
29.	sickness impact profile/
30.	(quality adj2 (wellbeing or well being)).ti,ab.
31.	sickness impact profile.ti,ab.
32.	disability adjusted life.ti,ab.
33.	(qal* or qtime* or qwb* or daly*).ti,ab.
34.	(euroqol* or eq5d* or eq 5*).ti,ab.
35.	(qol* or hql* or hqol* or h qol* or hrqol* or hr qol*).ti,ab.
36.	(health utility* or utility score* or disutilit* or utility value*).ti,ab.

37.	(hui or hui1 or hui2 or hui3).ti,ab.
38.	(health* year* equivalent* or hye or hyes).ti,ab.
39.	discrete choice*.ti,ab.
40.	rosser.ti,ab.
41.	(willingness to pay or time tradeoff or time trade off or tto or standard gamble*).ti,ab.
42.	(sf36* or sf 36* or short form 36* or shortform 36* or shortform36*).ti,ab.
43.	(sf20 or sf 20 or short form 20 or shortform 20 or shortform20).ti,ab.
44.	(sf12* or sf 12* or short form 12* or shortform 12* or shortform12*).ti,ab.
45.	(sf8* or sf 8* or short form 8* or shortform 8* or shortform8*).ti,ab.
46.	(sf6* or sf 6* or short form 6* or shortform 6* or shortform6*).ti,ab.
47.	or/28-46
48.	27 and 47

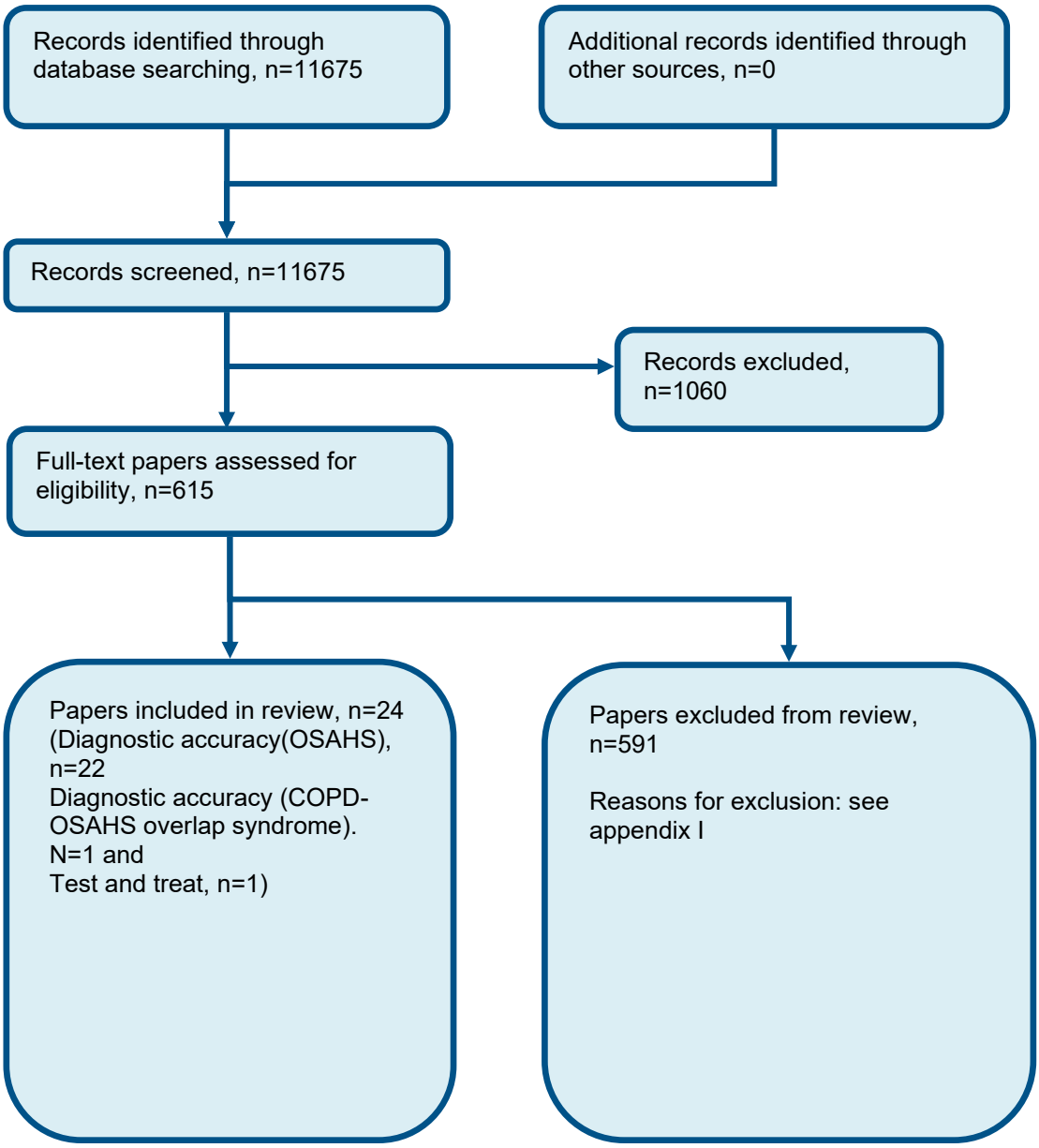
1 **Embase (Ovid) search terms**

1.	exp Sleep Disordered Breathing/
2.	(sleep* adj4 (apn?ea* or hypopn?ea*)).ti,ab.
3.	(sleep* adj4 disorder* adj4 breath*).ti,ab.
4.	(OSAHS or OSA or OSAS).ti,ab.
5.	(obes* adj3 hypoventil*).ti,ab.
6.	pickwick*.ti,ab.
7.	or/1-6
8.	limit 7 to English language
9.	letter.pt. or letter/
10.	note.pt.
11.	editorial.pt.
12.	case report/ or case study/
13.	(letter or comment*).ti.
14.	or/9-13
15.	randomized controlled trial/ or random*.ti,ab.
16.	14 not 15
17.	animal/ not human/
18.	nonhuman/
19.	exp Animal Experiment/
20.	exp Experimental Animal/
21.	animal model/
22.	exp Rodent/
23.	(rat or rats or mouse or mice).ti.
24.	or/16-23
25.	8 not 24
26.	quality adjusted life year/
27.	"quality of life index"/
28.	short form 12/ or short form 20/ or short form 36/ or short form 8/
29.	sickness impact profile/

30.	(quality adj2 (wellbeing or well being)).ti,ab.
31.	sickness impact profile.ti,ab.
32.	disability adjusted life.ti,ab.
33.	(qal* or qtime* or qwb* or daly*).ti,ab.
34.	(euroqol* or eq5d* or eq 5*).ti,ab.
35.	(qol* or hql* or hqol* or h qol* or hrqol* or hr qol*).ti,ab.
36.	(health utility* or utility score* or disutilit* or utility value*).ti,ab.
37.	(hui or hui1 or hui2 or hui3).ti,ab.
38.	(health* year* equivalent* or hye or hyes).ti,ab.
39.	discrete choice*.ti,ab.
40.	rosser.ti,ab.
41.	(willingness to pay or time tradeoff or time trade off or tto or standard gamble*).ti,ab.
42.	(sf36* or sf 36* or short form 36* or shortform 36* or shortform36*).ti,ab.
43.	(sf20 or sf 20 or short form 20 or shortform 20 or shortform20).ti,ab.
44.	(sf12* or sf 12* or short form 12* or shortform 12* or shortform12*).ti,ab.
45.	(sf8* or sf 8* or short form 8* or shortform 8* or shortform8*).ti,ab.
46.	(sf6* or sf 6* or short form 6* or shortform 6* or shortform6*).ti,ab.
47.	or/26-46
48.	25 and 47

Appendix C: Clinical evidence selection

Figure 2: Flow chart of clinical study selection for the review of diagnosis



1

Appendix D: Clinical evidence tables for diagnostic accuracy studies

Reference	**Calleja 2002[76]**
Study type	Cross-sectional
Study methodology	Data source: A total of 86 patients that had been referred to a sleep laboratory with a clinical diagnosis of SAS underwent cardiorespiratory polygraphy in an unattended mode using an ambulatory device (MERLIN). Analysis was carried out both automatically and manually. Conventional overnight full-channel polysomnography was performed simultaneously. Recruitment: not reported
Number of patients	n = 86 recruited, 79 analysed
Patient characteristics	Age, mean (SD): 52 (SD 11.1) Gender (male to female ratio): 77/9 Ethnicity: not reported Setting: sleep laboratory Country: Spain Inclusion criteria: not reported Exclusion criteria: not reported People with clinically suspected sleep apnoea/hypopnoea syndrome from a sleep outpatient clinic, and referred to the sleep laboratory for overnight polysomnography, were recruited to the study.
Target condition(s)	Sleep apnoea/hypopnoea syndrome

Reference	**Calleja 2002[76]**				
Index test(s) and reference standard	Index test: In-centre respiratory polygraphy (MERLIN system): The MERLIN system is a cardiorespiratory polygraph for level III studies. The unattended mode was selected for this study. The system records oronasal airflow by thermistor, chest and abdominal respiratory movements, tracheal sounds, cardiac frequency, oxygen saturation, body position, and continuous positive airway pressure (CPAP) level. Recordings were scored automatically by software included in the system or manually by visual evaluation of printouts. In all patients, sensors of the polysomnographical equipment were placed first. Respiratory events included apnoeas and hypopnoeas. The criteria of manual scoring were the same as that used for polysomnography. The respiratory effect index was calculated as the sum of the number of episodes of apnoea and hypopnoea per hour of polygraphical recording both in the automatic and manual analysis of data. An experienced neurophysiologist carried out the readings of the polygraphy system. The observers were blind to the results of the other method. Manual scored AHI of 9.8, post-hoc choice of cut-off with AHI ≥10; manual scored AHI of 6.7 with AHI ≥5. Reference standard Polysomnography (PSG), with no pre-specified AHI, RDI or ODI diagnostic of sleep apnoea/hypopnoea syndrome (Alice 3; Healthdyne Technologies or the Ultrasom system – Nicolet Biomedical Inc., Madison, WI, USA): PSG consisted of continuous polygraphical recordings for an entire night and included: electro-encephalography; electro-oculography; tibial and submental electromyograms; electrocardiogram (modified V2 lead). For respiratory sensors, nasal and oral signals by thermistors were used, tracheal sounds (microphone) and the chest and abdominal effort was measured by two belt sensors (Healthdyne piezo-electric gauge; Healthdyne Technologies). Oxyhaemoglobin saturation was recorded by finger-pulse oximeter (model 340; Palco Laboratories, Santa Cruz, CA, USA) and the body position was monitored by the system. Each 30-second epoch of the recording was scored for sleep stage, breathing, oxygenation, and movement. Sleep data were staged according to the system described by Rechtschaffen and Kales. A complete cessation of the thermistor signal of ≥10 seconds was defined as apnoea. Hypopnoea was defined as a discernible reduction of ≥50% of the thermistor signal for ≥10 seconds, accompanied by a decrease of ≥3% in oxyhaemoglobin saturation and/or an electro-encephalographic arousal. An arousal was defined according to the American Sleep Disorders Association. The total number of scored apnoeas and hypopnoeas divided by the number of hours of sleep, referred to as the AHI, was determined for each participant. The observers were blind to the results of the other method. Prevalence (AHI ≥ 10) – 64 subjects Time between measurement of index test and reference standard: polysomnography and respiratory polygraphy were performed simultaneously				
2×2 table All OSAS (AHI ≥ 10) Hospital RP		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test +	58	2	60	
	Index test −	6	13	19	
	Total	64	15	79	

Reference	**Calleja 2002[76]**
Statistical measures	Index text: in centre respiratory polygraphy, manually scored, AHI ≥10 (≥3% oxygen desaturation) Sensitivity: 90.6% Specificity: 86.7% Positive predictive value: not reported Negative predictive value: not reported Area under the curve, manually scored, (95% confidence interval) All OSA (AHI≥5): 0.976 (0.945 – 1006) Moderate-severe (AHI≥15): 0.954 (0.910 – 0.998) Severe (AHI≥30): 0.931 (0.863 - 0.999)
Source of funding	Supported by a grant from the Department of Health, Basque Government
Limitations	Risk of bias: Serious. Enrolment method unclear and inclusion/exclusion criteria not reported Indirectness: Serious. Proxy AHI ≥10 for index test was used.
Comments	Paper only provides totals and not TP, FP, FN, or TN. These have been calculated using diagnostic calculation spreadsheet using sensitivity, specificity, PPV, NPV and totals.

Reference	**Claman 2001[90]**
Study type	Cross-sectional
Study methodology	Data source: Simultaneous sleep monitoring was performed by formal polysomnography and by Bedbugg. Monitoring was performed in a university sleep centre in 42 subjects who had previously been scheduled for polysomnography. Recruitment: consecutive
Number of patients	n = 42 recruited and analysed
Patient characteristics	Age, mean (SD): 54 (SD 12.9) Gender (male to female ratio): 31/11

Reference	Claman 2001[90]
	Ethnicity: not reported Setting: sleep laboratory Country: USA Inclusion criteria: age over 18 years; clinical suspicion of uncomplicated obstructive sleep apnoea; patients already scheduled for full polysomnography. Exclusion criteria: exhibited flu-like symptoms; primary complaint of insomnia; suspected respiratory failure or hypoventilation; suspected narcolepsy or idiopathic hypersomnia. In addition, patients who had a family member present during the sleep study period were excluded, since the Bedbugg monitor is sensitive to sound.
Target condition(s)	Obstructive sleep apnoea
Index test(s) and reference standard	Index test: In-centre respiratory polygraphy (BedBugg): The BedBugg respiration sensor houses two microphones, one to measure respiration based on sound characteristics, and one for recording snoring intensity and ambient noise. The respiration sensor rests on the patient's upper lip and detects both nasal and oral airflow. The pulse oximeter is attached to the patient's index finger to measure blood oxygen saturation levels. The effort sensor is a soft, thin Tygon tube that is placed around the patient's upper midsection to detect respiratory effort. The Bedbugg had sufficient memory to record three consecutive nights of sleep. The data are scored by computer algorithm, and a detailed summary sent to the physician for diagnostic interpretation. For this study, a single night sleep was performed for direct comparison to PSG. AHI was determined based on the total duration of recorded data. Reference standard Polysomnography (PSG) with a pre-specified AHI >15 diagnostic of obstructive sleep apnoea: PSG was performed by technologists and included: EEG, EOG and EMG for sleep staging. Respiratory events were classified based on thermistor airflow, and thoracic and abdominal piezobands for effort. The BedBugg system performed a simultaneous recording using three additional sensors that provided five channels of data: airflow based on sound characteristics, snoring volume, respiratory effort, oxygen saturation, and heart rate derived from the oximetry signal. Each participants was hooked up to the three additional BedBugg sensors (respiration, effort, and Nonin 8500 finger oximeter) for the one-night sleep study, in addition to the electrodes used for a regular PSG study. The PSG airflow sensor and the BedBugg respiratory effort sensor were both placed between the upper lip and nose. The PSG data were scored manually by the technologist, using usual guidelines for sleep staging. Apnoea was defined as lack of airflow for 10 seconds. The hypopnoea criteria were a 50% reduction in airflow accompanied by at least a 4% oxygen desaturation. The data from the BedBugg recording unit were analysed using the BedBugg software. Outcome measures included number and duration of apnoeas and hypopnoeas, AHI, and oxygen saturation as derived by PSG standard and by BedBugg. For PSG, the AHI was based on sleep time. An AHI of greater than 15 was prespecified as positive for apnoea, and less than 15 as negative for apnoea.

Reference	**Claman 2001[90]**				
	Prevalence – 21 subjects had AHI>15 Time between measurement of index test and reference standard: simultaneous PSG and respiratory polygraphy in the sleep laboratory.				
2×2 table Moderate-severe (AHI ≥ 15)		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test +	18	1	19	
	Index test −	3	20	23	
	Total	21	21	42	
Statistical measures	Index text: in centre respiratory polygraphy, AHI ≥15 (≥4% oxygen desaturation) Sensitivity: 86% Specificity: 95% Positive predictive value: 94% Negative predictive value: 87.5% Area under the curve, manually scored, (95% confidence interval): not reported				
Source of funding	Supported by Sleep Solutions, Inc, Palo Alto, CA				
Limitations	Risk of bias: Serious. Inclusion/exclusion criteria not reported, and the test results could have been interpreted with knowledge of the other test results. Indirectness: None				
Comments	Paper only provides totals and not TP, FP, FN, or TN. These have been calculated using diagnostic calculation spreadsheet using sensitivity, specificity, PPV, NPV and totals.				

Reference	**de Oliveira 2009[100]**
Study type	Cross-sectional

Reference	de Oliveira 2009[100]
Study methodology	Data source: Patients with suspected OSAHS were submitted, in random order, to PM at the sleep laboratory concurrently with PSG (lab-PM) or at home-PM. Recruitment: consecutive
Number of patients	n = 157 studied, 121 analysed for home and laboratory monitoring
Patient characteristics	Age, mean (SD): 45 (SD 12) Gender (male to female ratio for PSG): 113/44 Ethnicity: not reported Setting: sleep centre/ at home Country: Brazil Inclusion criteria: not reported Exclusion criteria: pregnant women; patients with severe comorbidities ('cancer, heart failure, etc') or difficulties that would interfere with the examinations; patients residing outside the metropolitan area of Porto Alegre (Rio Grande do Sul, Brazil). Study participants were >18 years of age and referred for evaluation of suspected OSAS.
Target condition(s)	Obstructive sleep apnoea syndrome
Index test(s) and reference standard	Index test: Portable respiratory monitor (Somnocheck type 3 monitor, Weinmann GmbH, Hamburg, Germany): the Somnocheck monitor had a position sensor, pressure transducer, and pulse oximeter. The unit was adjusted to the participant's chest using a belt, and the nasal cannula was used to record airflow and snoring. The pulse oximeter recorded both oxygen saturation and heart rate. For the laboratory monitoring, a technician could help the participant when the monitor's alarms sounded. For the home study, the equipment was handed out to the participants, who were instructed on its use. For the home monitoring, the participants were instructed on how to wear the equipment as well as on how to relocate the sensors if the lost signal alarm sounded. Recordings shorter than 4 hours of artefact-free tracings were discarded. The portable monitor AHI was defined as the total number of apnoeas and hypopnoeas divided by the number of hours of artefact-free recording. Information from the sleep diary and position recording were used to exclude stretches of the recording in which wakefulness was indirectly deduced. The data were analysed manually. (Post-hoc choice of AHI threshold, 7 as cut-off point with PSG AHI ≥5)

<table>
<tr><td>Reference</td><td colspan="5">de Oliveira 2009[100]</td></tr>
<tr><td></td><td colspan="5"><u>Reference standard</u>
Laboratory polysomnography (PSG) with a diagnostic AHI ≥5 diagnostic for obstructive sleep apnoea syndrome: all participants completed nocturnal PSG, which included: EEG; electro-oculogram (left and right eyes); submental and anterior pretibial electromyograms and ECG. Airflow was measured by a nasal cannula attached to a pressure transducer through a Y-tube to allow connection to a pressure port of the portable monitor on the laboratory monitoring night. Arterial oxygen saturation was measured by a pulse oximeter. Sleep staging was performed using Rechtschaffen and Kales criteria.

(In centre PSG, AHI 5 or more), prevalence was 87 %.

Technicians were allowed to intervene in laboratory PSG and portable monitor studies in the case of technical issues. For both PSG and the portable monitor, apnoeas, hypopnoeas and AHI were defined according to standard criteria.

Time between measurement of index test and reference standard: the sleep studies were carried out in the laboratory and at home on two different nights and with a maximum interval of 48 hours; PSG and the Somnocheck were used simultaneously in the laboratory.

Prevalence AHI≥5 = 87% (105 participants)</td></tr>
<tr><td>2×2 table</td><td></td><td>Reference standard +</td><td>Reference standard −</td><td>Total</td><td rowspan="4">Calculated by NGC</td></tr>
<tr><td></td><td>Index test +</td><td>101</td><td>6</td><td>107</td></tr>
<tr><td></td><td>Index test −</td><td>4</td><td>10</td><td>14</td></tr>
<tr><td></td><td>Total</td><td>105</td><td>16</td><td>121</td></tr>
<tr><td>Statistical measures</td><td colspan="5"><u>Index text, home portable respiratory monitor, (AHI≥5)</u>
Sensitivity: 96.2%
Specificity: 64.7%
Positive predictive value: 94.3%
Negative predictive value: 73.3%

Area under the curve, manually scored, (95% confidence interval)
All OSA (AHI≥5): 0.96 (0.91 – 0.96)
Moderate-severe (AHI≥15): 0.91 (0.85 – 0.96)
Severe (AHI≥30): 0.92 (0.86 – 0.96)</td></tr>
</table>

Reference	**de Oliveira 2009[100]**
Source of funding	Not reported
Limitations	Risk of bias: Very serious. Unclear if study avoided inappropriate exclusions, the test results could have been interpreted with knowledge of the other test results, and 23% of study participants who underwent PSG were excluded from the analysis (36/157). Unclear if prevalence reported in the study was for all people who underwent polysomnography (149 patients) or just home respiratory polygraphy (121 patients) Indirectness: None
Comments	Paper only provides totals and not TP, FP, FN, or TN. These have been calculated using diagnostic calculation spreadsheet using sensitivity, specificity, PPV, NPV and totals.

Reference	**Emsellem 1990[119]**
Study type	Cross-sectional
Study methodology	Data source: Sixty-seven patients referred to a sleep laboratory with a tentative diagnosis of obstructive sleep apnea were examined with a device designed for home use as an apnea screening system. Recruitment: consecutive
Number of patients	n = 67 studied, 63 analysed
Patient characteristics	Age, mean (SD): 45 (SD not reported) Gender (male to female ratio): not reported Ethnicity: not reported Setting: sleep centre Country: USA Inclusion criteria: referral to the George Washington University Sleep Study Center or the Fairview Southdale Hospital Sleep Center with a tentative diagnosis of obstructive sleep apnoea. Exclusion criteria: not reported

<table>
<tr><td>Reference</td><td colspan="5">Emsellem 1990[119]</td></tr>
<tr><td>Target condition(s)</td><td colspan="5">Obstructive sleep apnoea</td></tr>
<tr><td>Index test(s) and reference standard</td><td colspan="5"><u>Index test:</u>
In-centre apnoea screening system (EdenTrace Model 2700 Multichannel Recorder – Edentec, Eden Prairie, Minn): The EdenTrace is a four-channel device measuring nasal/oral airflow by a thermistor or end tidal CO_2 gauge placed over the philtrum, chest wall movement by impedance, cardiac rhythm by ECG; and blood oxygen saturation by interfacing with a pulse oximeter. Output of the EdenTrace nasal/oral airflow channel was also interfaced directly to the (Grass or Nihon Kohden) standard polygraph to provide a precise temporal comparison of activity recorded by both systems. The presence and degree of oxygen desaturation was evaluated in all patients studied with the EdenTrace system. An AHI could not be calculated on the portable studies for lack of an EEG channel to document total sleep time. A separate index, the portable respiratory index was calculated by dividing the total number of disordered breathing events by the quiet recording time and multiplying by 60.

<u>Reference standard</u>
In-centre polysomnography (PSG) with a specified AHI >5 diagnostic of obstructive sleep apnoea: PSG parameters included electroencephalogram, chin electromyogram, anterior tibial electromyogram, electro-oculogram, electrocardiogram, tracings from nasal and oral respiration monitors (thermistor or end tidal CO_2 gauge), chest wall and abdominal excursion monitors (mercury strain gauges or Respitrace system [Ambulatory Monitoring, Inc., Ardsley, NY]), and ear oximeters (Biox IIA, [Ohmeda, Boulder, Colo], or Nellcor 100 [Nellcor Inc., Hayward, Calif]). All devices were connected to a 17 channel electroencephalograph (Nihon Kohden, Irvine, Calif) or polygraph (Grass Instruments Co., Quincy, Mass), and the resultant polysomnogram was recorded overnight.

(PSG AHI >5), prevalence 39 subjects

Episodes of apnoea and hypopnoea were scored together as disordered breathing events. A disordered breathing event was defined as a 50% or greater decrease in the amplitude of airflow lasting a minimum of 10 seconds. An AHI was calculated by dividing the total number of disordered breathing events by the total sleep time in minutes, then multiplying by 60.

Time between measurement of index test and reference standard: simultaneous PSG and apnoea screening system</td></tr>
<tr><td rowspan="4">2×2 table</td><td></td><td>Reference standard +</td><td>Reference standard −</td><td>Total</td><td rowspan="4">Provided in the paper</td></tr>
<tr><td>Index test +</td><td>37</td><td>1</td><td>38</td></tr>
<tr><td>Index test −</td><td>2</td><td>23</td><td>25</td></tr>
<tr><td>Total</td><td>39</td><td>24</td><td>63</td></tr>
</table>

Reference	**Emsellem 1990[119]**
Statistical measures	Index text, apnoea screening system, PSG AHI >5, in-centre Sensitivity: 95% Specificity: 96% Positive predictive value: not reported Negative predictive value: not reported Area under the curve, manually scored, (95% confidence interval): not reported
Source of funding	Not reported
Limitations	Risk of bias: Serious. Exclusion criteria not reported and the test results could have been interpreted with knowledge of the other test results Indirectness: None
Comments	Paper provides totals and TP, FP, FN, or TN. .

Reference	**Garg 2014[140]**
Study type	
Study methodology	Data source: Randomised crossover study of home PM (WatchPAT200) and in-laboratory simultaneous PSG and PM in 75 urban African Americans with high pre-test probability of OSA, identified with the Berlin questionnaire. Recruitment: unclear; randomised to home portable monitor or in-laboratory polysomnography and portable monitoring
Number of patients	n = 75 recruited and analysed
Patient characteristics	Age, mean (SD): 44.7 (10.6) Gender (male to female ratio): 18/57 Ethnicity: African American Setting: sleep centre Country: USA

Reference	Garg 2014[140]
	Inclusion criteria: not reported Exclusion criteria: past treatment of OSA (medical, dental, or surgical); other primary sleep disorder(s) by history (restless legs syndrome, insomnia, shift work); active uncontrolled medical conditions/immobility (congestive heart failure, severe COPD/asthma with frequent exacerbations in the preceding 6 months, severe arthritis/deformity of fingers); current drug (any non-prescription drug use besides over-the-counter drugs) or significant alcohol use (≥5 days per week); no current residential address or contact phone number; pregnancy; current drug therapy short acting nitrates or alpha blockers; cardiac pacemaker African Americans, age ≥18 years at a single tertiary care center, with high risk for OSA (defined by the Berlin Questionnaire) were recruited.
Target condition(s)	Obstructive sleep apnoea
Index test(s) and reference standard	Index test: Portable sleep monitor (WatchPAT200, Itamar Medical Inc): Home and in-laboratory test sessions were performed within 4 days of each other by all participants. A brief training session was conducted the day before home test session in the sleep laboratory for each participant including watching a 10 minute manufacturer provided instruction video on the application of WatchPAT200 and an up to 10 minute question-answer session with a registered polysomnography technician experienced in the application of WatchPAT200. In-laboratory portable monitoring was applied by a registered polysomnography technician concurrently with PSG channels. The technician did not troubleshoot for portable monitor technical problems such as the PAT probe coming loose during PSG. Automated software scoring was used for the AHI (zzzPAT, version 4.2.67.1a, Itamar Medical Ltd.) Specifically, a respiratory event was scored by the software if 1 to 3 criteria were met: (1) ≥30% PAT amplitude reduction together with a pulse rate accelerometer of 10% (2) ≥30% PAT amplitude reduction together with 3% oxyhaemoglobin desaturation, or (3) ≥4% oxyhaemoglobin desaturation. Data download were visually inspected by a board-certified sleep physician (blinded to home vs. in-laboratory portable monitor assignment) to make a determination of technical failure. Portable monitor tests where estimated total sleep time was ≤2 hours or PAT and oximetry data of interpretable quality did not meet published acceptable standards for minimum duration (≥4 hours per recording) were deemed 'technical failures'. Reference standard In-centre polysomnography (PSG) with no prespecified diagnostic AHI, RDI or ODI for obstructive sleep apnoea: a standard montage included electroencephalogram, bilateral electro-oculograms, electromyogram (submental, bilateral anterior tibial), electrocardiogram, oronasal airflow (thermistor and nasal pressure transducer), thoraco-abdominal motion (piezo-crystal, EPM Systems), arterial oxygen saturation by pulse oximetry, and body position. All signals including digital infrared video were acquired, processed and stored using the ALICE5 digital systems (Phillips Respironics). The PSG was scored according to published criteria. Hypopnoeas were defined as ≥30% reduction in airflow associated with ≥4% oxygen desaturation. Scoring was performed by a single registered polysomnography

<table>
<tr><td>Reference</td><td colspan="5">Garg 2014[140]</td></tr>
<tr><td></td><td colspan="5">technician and board certified sleep medicine physician blinded to participant identity, randomisation order, and test results from alternative tests (home and in-laboratory portable monitoring).

(PSG AHI ≥5 and PSG AHI ≥15 analysed below), prevalence: AHI≥5 =53 subjects, AHI≥15 = 41 subjects

Time between measurement of index test and reference standard: simultaneous in-centre PSG and portable monitoring</td></tr>
<tr><td rowspan="4">2×2 table All OSAS (AHI ≥5)</td><td></td><td>Reference standard +</td><td>Reference standard −</td><td>Total</td><td rowspan="4">Calculated by NGC</td></tr>
<tr><td>Index test +</td><td>51</td><td>13</td><td>64</td></tr>
<tr><td>Index test −</td><td>2</td><td>9</td><td>11</td></tr>
<tr><td>Total</td><td>53</td><td>22</td><td>75</td></tr>
<tr><td rowspan="4">2×2 table Moderate-severe OSAS (AHI ≥15)</td><td></td><td>Reference standard +</td><td>Reference standard −</td><td>Total</td><td rowspan="4">Calculated by NGC</td></tr>
<tr><td>Index test +</td><td>38</td><td>8</td><td>46</td></tr>
<tr><td>Index test −</td><td>3</td><td>26</td><td>29</td></tr>
<tr><td>Total</td><td>41</td><td>34</td><td>75</td></tr>
<tr><td>Statistical measures</td><td colspan="5"><u>Index text, portable sleep monitor (WatchPAT200), AHI ≥5, at home</u>
Sensitivity: 96%
Specificity: 43%
Positive predictive value: 79%
Negative predictive value: 82%

<u>Index text, portable sleep monitor (WatchPAT200), AHI ≥15, at home</u>
Sensitivity: 92%
Specificity: 77%
Positive predictive value: 83%
Negative predictive value: 88%

Area under the curve, manually scored, (95% confidence interval)
All OSA (AHI≥5): 0.9093 (CI not reported)
Moderate-severe (AHI≥15): 0.9224 (CI not reported)
Severe (AHI≥30): not reported</td></tr>
<tr><td>Source of funding</td><td colspan="5">Supported by NIH KM1CA156717 Career Development Award in Comparative Effectiveness Research from the National Cancer Institute</td></tr>
</table>

Reference	**Garg 2014[140]**
Limitations	Risk of bias: Serious. Enrollment method unclear, unclear if all study exclusion criteria appropriate, and unclear whether the index test was interpreted without knowledge of the reference standard Indirectness: None
Comments	Paper only provides totals and not TP, FP, FN, or TN. These have been calculated using diagnostic calculation spreadsheet using sensitivity, specificity, PPV, NPV and totals.

Reference	**Gjevre 2011[145]**
Study type	Cross-sectional
Study methodology	Data source: Consecutive women scheduled for routine PSG testing for evaluation of clinically suspected OSA and who met inclusion/exclusion criteria, were invited to participate. An in-home Embletta portable monitor test was performed one week before or after diagnostic PSG. Recruitment: consecutive
Number of patients	n = 47 recruited and analysed
Patient characteristics	Age, mean (SD): 52 (11) Gender (male to female ratio): all women Ethnicity: Setting: sleep centre and home Country: Canada Inclusion criteria: 21 to 70 years old, and able to provide informed consent Exclusion criteria: referring sleep physician's strong suspicion of another primary sleep disorder (e.g., primary insomnia, narcolepsy, restless legs syndrome, a parasomnia or nocturnal seizures), regular shift work in the previous six months, history of lung disease, congestive heart failure, unstable angina, cerebrovascular accident or pregnancy in the previous six months, neuromuscular disease or renal failure

<table>
<tr><td>Reference</td><td colspan="4">Gjevre 2011[145]</td></tr>
<tr><td>Target condition(s)</td><td colspan="4">Obstructive sleep apnoea</td></tr>
<tr><td>Index test(s) and reference standard</td><td colspan="4"><u>Index test:</u>
Portable sleep monitor (Embletta, model 2601-1 PDS X10Xact Trace [Embletta, USA]), at home (with AHI and ODI): unattended, in-home monitoring included monitoring of oxygen saturation, heart rate, ribcage and abdominal movements, nasal airflow pressure, thermal flow, snoring and body position. In the afternoon before the test, an experienced technician taught the patient how to apply the device in the home. A registered sleep technologist, blinded to other patient and PSG data, scored the in-home monitoring tests, which were then reviewed and verified by a single blinded sleep physician. Major outcomes included AHI (using the American Academy of Sleep Medicine alternative criteria for apnoea and hypopnoea [50% drop in nasal pressure from baseline and a 3% desaturation]) and the oxygen desaturation index (number of events/hour when the oxygen saturation decreases by >3%. The patient recorded the approximate time of sleep onset and awakening in a sleep log. The sleep log data were used to estimate sleep duration. In the event of a technically suboptimal Embletta study, the study was repeated.

<u>Reference standard</u>
In-laboratory polysomnography (PSG) with a pre-specified AHI >5 diagnostic of obstructive sleep apnoea: a 15-lead diagnostic PSG was performed in the sleep laboratory. PSG recordings included: electroencephalogram, electro-oculogram, submental electromyogram, pulse oximetry, an oronasal airflow pressure sensor, chest and ribcage movement using piezoelectric belts, snore (vibration sensor), intercostal diaphragmatic and anterior tibialis electromyography, and an electrocardiogram. Sleep position was recorded by the sleep technician and confirmed by an all-night infrared video camera. Signals were recorded digitally using Sandman software (Mallinckrodt Inc, Canada). Scoring was performed by a registered sleep technician, and subsequently reviewed and verified by a single blinded sleep physician. Sleep staging was analysed using AASM criteria. The AHI was determined using the AASM alternative criteria, and the results were scored blinded. OSA was defined as >5 apnoeas/hour of sleep (of at least 10 seconds duration) and/or hypopnoeas/hour of sleep (at least a 50% decrease in flow for at least 10 seconds duration, with either a 3% decrease in oxygen saturation or a significant activation in the electroencephalogram/hour of sleep.

(PSG AHI >5) Prevalence AHI≥5 =32 subjects

Time between measurement of index test and reference standard: portable monitoring with Embletta was undertaken in random sequence order one week before or after PSG.</td></tr>
<tr><td>2×2 table all OSAS (AHI ≥ 5)</td><td></td><td>Reference standard +</td><td>Reference standard −</td><td>Total</td><td rowspan="4">Calculated by NGC</td></tr>
<tr><td></td><td>Index test +</td><td>29</td><td>6</td><td>35</td></tr>
<tr><td></td><td>Index test −</td><td>3</td><td>9</td><td>12</td></tr>
<tr><td></td><td>Total</td><td>32</td><td>15</td><td>47</td></tr>
</table>

Reference	**Gjevre 2011[145]**
Statistical measures	Index text, portable sleep monitor (Embleta, model 2601-1 PDS X10Xact Trace), AHI ≥ 5, at home Sensitivity: 90.6% Specificity: 60% Positive predictive value: 82.86% Negative predictive value: 75% Area under the curve, manually scored, (95% confidence interval): 0.879 (0.782 to 0.976)
Source of funding	The study was funded by a grant from the Saskatchewan Health Research Foundation
Limitations	Risk of bias: Serious. Unclear if all study exclusion criteria appropriate, and unclear whether the reference standard was interpreted without knowledge of the index test Indirectness: None
Comments	All female study population; Paper only provides totals and not TP, FP, FN, or TN. These have been calculated using diagnostic calculation spreadsheet using sensitivity, specificity, PPV, NPV and totals.

Reference	**Golpe 2002[149]**
Study type	Cross-sectional
Study methodology	Data source: prospective case-study, sleep disorders unit of the tertiary referral university hospital. Recruitment: unclear; for portable monitoring, study participants were randomised to home monitoring with technician intervention in the set-up of the equipment, or to a 15-20 minute training period in the hospital provided by a technician, as well as written instructions regarding the use of the sleep-recording device – the latter group had the home study performed with the patient's own set-up of the equipment
Number of patients	n = 55 recruited, 37 analysed
Patient characteristics	Age, mean (SD): 52.7 (13.3) Gender (male to female ratio): 53/2

Reference	Golpe 2002[149]
	Ethnicity: Setting: sleep centre Country: Spain Inclusion criteria: patients referred to the sleep-disorders unit for evaluation of suspected OSAHS who lived within 30km of the hospital. All patients had to have at least two of the following: loud snoring, observed apnoeas, and daytime drowsiness, and were judged by one of the authors to require a sleep study (snoring and apnoeas were assessed using a questionnaire that was filled out by the patient. Drowsiness was assessed using the Epworth sleepiness scale score, whereby a score ≥11 was considered pathologic). Exclusion criteria: physical or mental impairment that precluded the use of the equipment
Target condition(s)	Sleep apnoea/hypopnoea syndrome
Index test(s) and reference standard	Index test: Portable sleep recording device (Apnoescreen-I: CNS-Jaëger; Höchberg, Germany), at home: this five-channel recording device produces a computerised recording of variations in oronasal airflow (measured by thermistor), body position, wrist actimetry, pulse rate, and arterial oxygen saturation (measured by finger pulse oximetry). Study participants were randomised to home monitoring with technician intervention in the set-up of the equipment, or to a 15-20 minute training period in the hospital provided by a technician, as well as written instructions regarding the use of the sleep-recording device – the latter group had the home study performed with the patient's own set-up of the equipment. The recording device estimates the total sleep time from the wrist actimetry registry, eliminating from the total registry time those periods with high activity. It automatically calculates the number of apnoeas plus hypoponeas per hour of estimated sleep time. It also provides parameters derived from the oximetry record, including the number of desaturations ≥4% per hour of estimated sleep time, and the cumulative percentages of sleep time at saturations <90%. Additionally, manual analysis was undertaken. The graphic display of the sleep-recording device does not allow to measure manually with accuracy at the level of desaturation. Therefore, no definite threshold for the desaturations was used, and any discernible drop in saturation was considered to be significant. The total number of apnoeas plus hypopnoeas was divided by the registry time and the sleep time in hours (as calculated by the equipment software), obtaining the manual RDI per hour of registry time and the manual RDI per hour of sleep time, respectively. Reference standard In-laboratory polysomnography (PSG) with a prespecified AHI ≥10 diagnostic of sleep apnoea/hypopnoea syndrome: PSG included EEG, chin electromyogram, electro-oculogram, ECG, thoraco-abdominal movement by piezoelectric bands placed over the thorax and abdomen, oronasal flow by thermistor, tibial electromyograms, oxygen saturation with a finger sensor (Oxypleth; Novametrix Medical Systems; Wallingford, CT), body position, and snoring. All signals were recorded through a 14-channel polygraph (Medelec; Vickers

Reference	**Golpe 2002[149]**				
	Medical; Basingstoke, Hampshire, UK). One of the authors carried out the PSG analysis, blind to the result of the home study device recording. PSG records were scored in 30-second epochs. Apnoea was defined as a complete cessation of airflow lasting ≥10 seconds. Hypopnoea was defined as a discernible reduction in respiratory airflow lasting ≥10 seconds and accompanied by a decrease of ≥4% in oxygen saturation and/or an arousal. This definition of hypopnoea is in accordance with the current guidelines of the Spanish Society of Pulmonology and Thoracic Surgery. The reason for counting 'discernible' reductions in respiratory airflow instead of using a numerical threshold is that thermistors only allow a qualitative estimation of airflow. The AHI was calculated as the average number of episodes of apnoea and hypopnoea per hour of sleep. A cut-off point of 10 was used to diagnose SAHS. Arousals were defined according to a report from the American Sleep Disorders Association Atlas task force. Sleep data were staged according to the system of Rechtschaffen and Kales. Prevalence – 19 subjects Time between measurement of index test and reference standard: In-laboratory PSG was performed within one month of the home sleep monitoring				
2×2 table All OSA (AHI≥10)		Reference standard +	Reference standard −	Total	Provided by the study, doubtful studies excluded from analysis
	Index test +	18	3	21	
	Index test −	1	15	16	
	Total	19	18	37	
Statistical measures	Index text, portable sleep recording device, at home, AHI ≥10 Sensitivity: 94.7% Calculated by NGC Specificity: 83.3% Calculated by NGC Positive predictive value: not reported Negative predictive value: not reported Area under the curve, manually scored, (95% confidence interval): not reported				
Source of funding	Supported by a grant from Fundación Marqués de Valdecilla				
Limitations	Risk of bias: Serious. Enrollment method unclear; unclear if all study exclusion criteria appropriate; unclear whether the index test was interpreted without knowledge of the reference standard, and 33% of recruited study participants were not included in the analysis (18/55) Indirectness: Serious. Proxy AHI ≥10 for index test was used.				

Reference	**Golpe 2002[149]**
Comments	Paper only provides TP, FP, FN, or TN. Sensitivity and specificity have been calculated using diagnostic calculation spreadsheet using TP, FP, FN or TN

Reference	**Goodrich 2009[151]**
Study type	Cross-sectional
Study methodology	Data source: PSG was performed with simultaneous utilisation of the Lifeshirt on 50 individuals who met screening criteria for obstructive sleep apnea. Participants came to the sleep laboratory approximately 2 h before their normal bedtime Recruitment: consecutive
Number of patients	n = 50 recruited, 48 analysed
Patient characteristics	Age, mean (SD): 44 (range 22 to 69) Gender (male to female ratio): 35/13 Ethnicity: not reported Setting: sleep centre Country: USA Inclusion criteria: symptoms suggestive of obstructive sleep apnoea (e.g. reports of regular snoring, gasping or choking for air while attempting to sleep, and daytime sleepiness); heartburn at least three times per week; and use of over-the-counter medications for heartburn several times per week. Exclusion criteria: history of abdominal surgery, significant respiratory illnesses such as chronic obstructive pulmonary disease or asthma, neurological or psychiatric disorders requiring regular medication, significant medical conditions such as chronic renal or liver disease, and a history of Barrett's oesophagus.
Target condition(s)	Obstructive sleep apnoea
Index test(s) and reference standard	Index test: Portable respiratory polygraphy (Lifeshirt, Vivometrics; Ventura, CA), in-centre: the Lifeshirt is a form-fitting vest. Sensors embedded within the shirt are capable of monitoring a range of physiological parameters. In this study, sleep technicians prepared each patient for sleep, and ensured that the Lifeshirt was operating correctly. All Lifeshirt data were scored by automated analysis by Vivometrics, and

<table>
<tr><td>Reference</td><td colspan="4">Goodrich 2009[151]</td></tr>
<tr><td></td><td colspan="4">completely independent of the PSG scoring. Technicians at Vivometrics review all computer results; when there is any discrepancy between the automated analysis and the technician (e.g. due to artefact), the technician can restore part or all of the sleep study to make it more accurate. The Lifeshirt uses an algorithm that distinguishes between apnoeas and hypopnoeas with the following definitions: obstructive apnoea is a reduction in tidal volume of more than 75% compared to baseline with continuing efforts to breathe seen in the ribcage and abdomen, with ≥3% oxygen desaturation. Central apnoea consists of a complete cessation of respiratory efforts in the ribcage and abdomen (i.e. tidal volume equal to zero), with a ≥3% oxygen desaturation. Hypopnoea is a drop in tidal volume of greater than 25% and less than 50% compared to baseline in combination with ≥3% oxygen desaturation. All apnoeas and hypopnoeas must be at least 10 seconds in length. Since the Lifeshirt did not measure EEG, the AHI was based on apnoeas and hypopnoeas per hour of monitoring. The Lifeshirt measures ventilation through respiratory inductive plethsymography bands that are located at the ribcage and abdomen. A proprietary algorithm computes breath volume and compares it to the median breath volume of the preceding two-minute interval in order to detect respiratory events.

<u>Reference standard</u>
In-centre polysomnography (PSG) with no prespecified AHI diagnostic of obstructive sleep apnoea: study participants arrived at the sleep laboratory two hours before bedtime. Experienced sleep technicians prepared the patients for complete PSG including electroencephalography; chin and leg electromyography; electrocardiography; electro-oculography; airflow; respiratory effort (chest and abdominal belts), and oxygen saturation. A nasal cannula was used for airflow. Sleep stages were scored manually according to Recthschaffen and Kales' criteria. Obstructive sleep apnoea was defined as a drop in airflow of at least 80% but with continuing respiratory efforts seen in the chest and abdomen. Central apnoea also consisted of a drop in airflow of at least 80% accompanied by a similar decrease in both chest and abdominal belts. A hypopnoea was defined as a decrease in airflow of at least 30% that was accompanied by an oxygen desaturation of at least 3%. Respiratory events had to last at least 10 seconds to qualify as apnoeas or hypopnoeas. The AHI consisted of the number of apnoeas and hypopnoeas per hour of sleep. Arousals were scored to the criteria set forth by the American Sleep Disorders Association. The studies were scored by experienced staff who were blinded to the results of the Lifeshirt data.

PSG AHI ≥5, AHI≥15 and AHI≥30 analysed below. Prevalence AHI ≥5 = 39 subjects, AHI ≥15 = 15 subjects, AHI ≥30 =8

Time between measurement of index test and reference standard: simultaneous PSG and Lifeshirt recordings</td></tr>
<tr><td>2×2 table All OSAS (AHI ≥ 5)</td><td></td><td>Reference standard +</td><td>Reference standard −</td><td>Total</td><td rowspan="4">Calculated by NGC</td></tr>
<tr><td></td><td>Index test +</td><td>33</td><td>3</td><td>36</td></tr>
<tr><td></td><td>Index test −</td><td>6</td><td>6</td><td>12</td></tr>
<tr><td></td><td>Total</td><td>39</td><td>9</td><td>48</td></tr>
</table>

Reference	**Goodrich 2009[151]**				
2×2 table moderate-severe OSAS (AHI ≥ 15)		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test +	13	6	19	
	Index test −	2	27	29	
	Total	15	33	48	
2×2 table Severe OSAS (AHI ≥ 30)		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test +	7	0	7	
	Index test −	1	40	41	
	Total	8	40	48	
Statistical measures	Index text, portable respiratory polygraphy, AHI >5, in-centre Sensitivity: 85% Specificity: 67% Positive predictive value: not reported Negative predictive value: not reported Index text, portable respiratory polygraphy, AHI >15, in-centre Sensitivity: 87% Specificity: 82% Positive predictive value: not reported Negative predictive value: not reported Index text, portable respiratory polygraphy, AHI >30, in-centre Sensitivity: 88% Specificity: 100% Positive predictive value: not reported Negative predictive value: not reported Area under the curve, manually scored, (95% confidence interval) All OSA (AHI≥5): 0.76 (CI not provided) Moderate-severe (AHI≥15): 0.84 (CI not provided) Severe (AHI≥30): 0.94 (CI not provided)				

Reference	**Goodrich 2009[151]**
Source of funding	The manufacturer of the Lifeshirt loaned the authors the Lifeshirts used in this study. No financial support was provided for this project.
Limitations	Risk of bias: None overall although unclear if all study exclusion criteria appropriate; 4% of recruited study participants were not included in analysis Indirectness: None
Comments	Paper only provides totals and not TP, FP, FN, or TN. These have been calculated using diagnostic calculation spreadsheet using sensitivity, specificity, PPV, NPV and totals.

Reference	**Gyulay 1993[162]**
Study type	Cross-sectional
Study methodology	Data source: patients referred for assessment of snoring and/or daytime somnolence were assessed clinically and then underwent both unsupervised oximetry in their homes and formal polysomnography. Recruitment: consecutive
Number of patients	n = 98 recruited and analysed
Patient characteristics	Age, mean (SD): 49.96 (2.5) Gender (male to female ratio): 77/21 Ethnicity: not reported Setting: sleep centre and home Country: Australia Inclusion criteria: not reported Exclusion criteria: not reported The study population included patients referred to a specialist sleep centre because of a question of OSA. All were habitual snorers; those identified as having significant chronic lung disease were not included. Patients found at oximetry to have arterial oxygen desaturation (SaO_2 ≤90%) during wakefulness were not excluded. Twenty patients were not included because they lived too far from the laboratory for overnight oximetry to be feasible.

Reference	**Gyulay 1993[162]**				
Target condition(s)	Obstructive sleep apnoea				
Index test(s) and reference standard	Index test: Pulse oximetry (Model Biox 3700; Ohmeda, Boulder, CO) with a desaturation index ≥15 (4%), at home: the pulse oximeter recorded saturation continuously, but stored the lowest value recorded in a 12-second epoch. The alarm circuits of the oximeters were inactivated. The patients were instructed to turn the oximeter on at lights out and to turn it off when they got up the next morning. No instructions on alcohol consumption or other aspects of sleep routine were given. When the oximeter was returned, patients filled out at hospital sleep questionnaire, and patients reporting no sleep or very poor sleep were asked to have a second night of oximetry. The number of falls of 2% or more, 3% or more, and 4% or more from baseline were calculated by computer analysis. The first desaturation was recorded when a single reading lower than baseline SaO_2 by the appropriate amount (2%, 3% or 4%) was observed. The desaturation event was considered to end when SaO_2 rose 2% if 2% desaturations were being counted or 3% if 3% or 4% desaturations counted. If a further fall occurred, a second event was counted. An event was also considered to end if SaO_2 remained below baseline by the appropriate amount for more than 3 minutes, and a second event was counted even if SaO_2 fell no lower. Events longer than 3 minutes were enumerated separately by the computer and subtracted from the total before calculation of the desaturation index (DI). The DI was calculated for 2%, 3% and 4% falls in SaO_2. No rules for interpretation of the data were offered, but after inspecting these, the clinicians reviewed their estimates of the likelihood of clinically significant OSA. (DI4% ≥15) Reference standard Laboratory polysomnography (PSG) with a prespecified AHI ≥15 (no % desaturation criteria) diagnostic of obstructive sleep apnoea: PSG was analysed manually without knowledge of the oximetry result. Methods and equipment not reported in detail; apnoea was defined as cessation of oronasal airflow for more than 10 seconds, and hypopnoea as a reduction of oronasal airflow to 50% or less of the value prevailing during preceding normal breathing for at least 10 seconds. Desaturation was not a criterion for scoring either apnoea or hypopnoea. OSA was defined as AHI ≥15. With these data the clinicians made a decision on the need for nasal CPAP treatment. Prevalence (AHI≥15) = 43 patients Time between measurement of index test and reference standard: laboratory PSG was performed between 2 weeks and 3 months after home pulse oximetry				
2×2 table Moderate-severe (AHI ≥15)		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test +	17	1	18	
	Index test −	26	54	80	
	Total	43	55	98	

Reference	**Gyulay 1993[162]**
Statistical measures	Index text, pulse oximetry, desaturation index ≥15 (4%), at home Sensitivity: 40% Specificity: 98% Positive predictive value: Not reported Negative predictive value: Not reported Area under the curve, manually scored, (95% confidence interval): not reported
Source of funding	Supported by the National Health and Medical Research Council of Australia
Limitations	Risk of bias: Serious. inclusion/exclusion criteria reported incompletely, and the index test could have been interpreted with knowledge of the reference standard results. Indirectness: None
Comments	% oxygen desaturation not included in AHI criteria. Details not reported on the timing and number of repeated oximetry tests; Paper only provides totals and not TP, FP, FN, or TN. These have been calculated using diagnostic calculation spreadsheet using sensitivity, specificity, PPV, NPV and totals.

Reference	**Jen 2020[181]**
Study type	Cross-sectional
Study methodology	Data source: not stated Recruitment: consecutive
Number of patients	n = 33 analysed
Patient characteristics	Age, mean (SD): 63 (7); Gender (male to female ratio): 61% male Ethnicity: not reported Setting: sleep laboratory

Reference	Jen 2020[181]
	Country: USA Inclusion criteria: Adult patients (18 years of age) with known COPD as diagnosed by a pulmonologist (defined as Global Initiative for Chronic Obstructive Lung Disease, GOLD stage 2 or higher and ≥10 pack-years of smoking history) were screenedbetween July 2015 and August 2016. Recruitment was performed outside any clinical care via flyers posted in the community and pulmonary clinics, and from a local community study of COPD. Exclusion criteria: for the study were unstable COPD or active cardiovascular disease, defined as recent hospitalisation within 3 months; medical conditions that would affect the diagnostic accuracy or application of WatchPAT including history of peripheral vascular disease, peripheral neuropathy, non-sinus cardiac rhythm, permanent pacemaker, finger deformity that precluded adequate sensor application. Informed consent was obtained from all participants after the protocol was approved by the Human Research Protections Program/Institutional Review Board of University of California, San Diego.
Target condition(s)	Overlap syndrome
Index test(s) and reference standard	Index test At the same time as the in-lab PSG, all subjects simultaneously wore the WatchPAT 200 (Itamar Medical Ltd.,Caesarea, Israel). WatchPAT 200 is a device worn around the wrist with one finger probe and separate snoring sensor. The finger probe records the peripheral arterial tonometry (PAT) signal, heart rate, oxygen saturation with an actigraph built in with the recording device on the wrist. Sleep time was estimated by the actigraphy signal, and sleep stage was determined through PAT analysis, the details of which have been previously described [19]. Respiratory events were identified using a combination of PAT signal attenuation, heart rate changes, and desaturation on pulse oximetry and analyzed by the WatchPAT proprietary software algorithm . Only the automated scoring of WatchPAT studies was used. Reference standard All subjects underwent a standard in-laboratory overnight PSG. Signals recorded included: electrooculography (EOG), electrocardiography (ECG), submental and tibial electromyography (EMG), electroencephalography (EEG), chest and abdominal respiratory movement, nasal and oral airflow (measured by a mask with pneumotach; if the subjects were unable to tolerate the mask, nasal–oral thermistor and nasal pressure were used), oxygen saturation, and snoring intensity. Subjects were encouraged to sleep supine. All of the PSGs were scored by one registered polysomnographic technologist (RPSGT) according to the American Academy of Sleep Medicine guidelines (Chicago criteria) . The scoring was completed without knowledge of the WatchPAT results. Prevalence: AHI≥5 = 72.7% (24 subjects), AHI ≥15 = 39.4% (13 subjects), AHI ≥30 = 27.3% (9 subjects)

Reference	**Jen 2020[181]**				
	Time between measurement of index test and reference standard: at the same time				
2×2 table AHI≥5		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test +	23	4	27	
	Index test −	1	5	6	
	Total	24	9	33	
2×2 table AHI≥15		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test +	12	7	19	
	Index test −	1	13	14	
	Total	13	20	33	
2×2 table AHI≥30		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test +	8	1	9	
	Index test −	1	23	24	
	Total	9	24	33	
Statistical measures	Index text: partially attended night-time recording, AHI≥5 Sensitivity 95.8% Specificity 55.6% Positive predictive value: not reported Negative predictive value: not reported Area under the curve, manually scored, (95% confidence interval) : not reported Index text: partially attended night-time recording, AHI≥15 Sensitivity 92.3% Specificity 65% Positive predictive value: not reported Negative predictive value: not reported Area under the curve, manually scored, (95% confidence interval) : not reported Index text: partially attended night-time recording, AHI≥30				

Reference	**Jen 2020[181]**
	Sensitivity 88.9% Specificity 95.8% Positive predictive value: not reported Negative predictive value: not reported Area under the curve, manually scored, (95% confidence interval) : not reported
Source of funding	This study was supported by Fondo de Investigaciones Sanitarias, Commissionat per Universitats i Recerca de la Generalitat de Catalunya
Limitations	Risk of bias: Serious. Indirectness: None
Comments	Paper only provides totals and not TP, FP, FN, or TN. These have been calculated using diagnostic calculation spreadsheet using sensitivity, specificity, PPV, NPV and totals.

Reference	**Lloberes 1996[242]**
Study type	Cross-sectional
Study methodology	Data source: not stated Recruitment: ‘patients…studied at random’
Number of patients	n = 76 analysed
Patient characteristics	Age, mean (SD): 51 (11.5); range 24-82 Gender (male to female ratio): 54/22 Ethnicity: not reported Setting: respiratory ward or sleep laboratory

Reference	**Lloberes 1996[242]**
	Country: Spain Inclusion criteria: not reported Exclusion criteria: not reported The study population included adults with a mean body mass index of 31 (5.7) kg/m^2 (range 17-48) referred to a sleep clinic for evaluation of OSAHS during a three month period
Target condition(s)	Sleep apnoea/ hypopnoea syndrome
Index test(s) and reference standard	Index test Partially attended night-time respiratory recording: the intended use of this index test was to assess whether simplified respiratory recording could reduce the requirement for full polysomnography. The respiratory recording was performed using a Densa Pneumograph (Densa Ltd, Flint, UK) which measures oronasal airflow by a thermistor and chest and abdominal motion using strain gauges. The pulse oximeter was the same as that used for full polysomnography. A trained nurse connected the patient to the monitoring system in approximately 10 minutes. The recording could be observed throughout the night on a computer screen located in front of the nurse's desk, allowing easy detection of any technical abnormality. Apnoea and hypopnoea were defined, respectively, as a reduction of at least 80% or 50% in airflow, both associated with a higher than 2% dip in arterial oxygen saturation with respect to the previous 30 seconds. The number of reductions in phase angle between chest and abdominal waveforms per hour higher than 10 was also assessed. Reference standard Laboratory polysomnography (PSG) with prespecified apnoea/hypopnoea index (AHI) of >10 diagnostic of OSAHS. 28% of participants had an AHI-PSG <10. PSG included electroencephalographic, chin electromyographic and electro-oculographic recordings (to standard criteria), arterial oxygen saturation (measured continuously with a finger probe using a pulse oximeter – 504 Critical Care System Inc, Waukesha, USA), rib cage and abdominal motion (monitored by piezoelectric bands placed on the thorax and abdomen – Reso-Ez, Bionic, Midlothian, Virginia, USA), and airflow recordings (using a thermistor). All signals were recorded continuously on a polygraph (Nicloet 1A98 Madison, Wisconsin, USA). The technician spent 30 minutes connecting the patient to the monitoring system, three hours manually scoring the recording, and stayed with the patient all night. Analysis of full PSG and the index test was carried out by the same individuals blinded to the result of the other study. The mean AHI obtained using the index test was compared with that obtained with full PSG. Prevalence AHI≥10 = 55 subjects Time between measurement of index test and reference standard: on two different nights within three weeks

Reference	**Lloberes 1996[242]**				
2×2 table, AHI≥10		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test +	45	2	47	
	Index test −	10	19	29	
	Total	55	21	76	
Statistical measures	Index text: partially attended night-time recording, AHI Sensitivity 82% Specificity 90% Positive predictive value: 96% Negative predictive value: 65.5% Area under the curve, manually scored, (95% confidence interval) : not reported				
Source of funding	This study was supported by Fondo de Investigaciones Sanitarias, Commissionat per Universitats i Recerca de la Generalitat de Catalunya				
Limitations	Risk of bias: Serious. Enrollment method unclear; inclusion/exclusion criteria not reported Indirectness: serious, proxy values AHI ≥ 10 used for both index test and reference standard				
Comments	Paper only provides totals and not TP, FP, FN, or TN. These have been calculated using diagnostic calculation spreadsheet using sensitivity, specificity, PPV, NPV and totals.				

Reference	**Marrone 2001[286]**
Study type	Cross-sectional
Study methodology	Data source: he reliability of a POLYMESAM (PM) instrument in the detection of ventilatory disorders and in the diagnosis of obstructive sleep apnea syndrome (OSAS) was evaluated in 50 subjects suspected for OSAS, simultaneously studied by polysomnography (PSG) in a sleep laboratory. Recruitment: consecutive

Reference	**Marrone 2001[286]**
Number of patients	n = 50 analysed
Patient characteristics	Age, mean (SD): 49.6 ± 10.2 (units not reported) Gender (male to female ratio): 40/10 Ethnicity: not reported Setting: laboratory Country: Italy Inclusion criteria: not reported Exclusion criteria: not reported Study participants had a history of heavy snoring but showed a variable degree of subjective somnolence (Epworth score 10.2 ± 4.3).
Target condition(s)	Obstructive sleep apnoea syndrome
Index test(s) and reference standard	Index test Portable sleep monitor (POLYMESAM): this device consists of a recorder, to which multiple sensors are linked for the detection of the following signals: oxyhaemoglobin saturation (by a finger sensor), heart rate [derived from three ECG electrodes on the chest], snoring sound (by a microphone placed on the thyroid cartilage), body posture, oronasal airflow (by a three-fold thermocouple sensor for both nostrils and mouth), thoracic and abdominal movements (by stretch belts), and optionally, either limb activity or continuous positive airway pressure (CPAP). The system can work as a stationary or as an ambulant recorder. Software for automatic analysis is provided; however, all raw data can be visualised on the computer so that the automatic analysis can be manually corrected, with the exception of ECG that can be visualised only as heart rate. The duration of the recording by the monitor was predetermined. Reference standard Laboratory polysomnography (PSG) with a prespecified AHI of ≥10 diagnostic of obstructive sleep apnoea syndrome: PSG was recorded by a computerised system (Somnostar, Sensormedics, Yorba Linda, CA, USA). A standard montage was used, including two electroencephalograms, right and left electro-oculograms, submental electromyogram, oronasal airflow by thermocouple, thoracic and abdominal movements by piezoelectric belts, oxyhaemoglobin saturation, electrocardiogram, and body posture. A technician was in attendance of the patients; he controlled PSG recording and was allowed to fix any failing signal, but he could not visualise signals recorded by the portable sleep monitor. After an automatic scoring of both recordings, the whole computerised analyses were corrected manually. On both recording of each patient, the following events were scored: central apnoeas (Ac), defined

<table>
<tr><td>Reference</td><td colspan="5">Marrone 2001[286]</td></tr>
<tr><td></td><td colspan="5">as absence of airflow for at least ten seconds, associated with the lack of any thoraco-abdominal movement; obstructive apnoeas (Ao), defined as absence of airflow for at least ten seconds, associated with the persistence of thoraco-abdominal movements; mixed apnoeas (Am), defined as events starting as central apnoeas and coming to an end as obstructive apnoeas; hypopnoeas (H), defined as discernible reductions in the airflow signal for at least 10 seconds, associated with a decrease in oxyhaemoglobin saturation by at least 4%. The duration of each event was measured. The frequency of each kind of event was normalised per hour of time in bed (TIB), so as to obtain the following indices: Ac/TIB, Ao/TIB, Am/TIB and H/TIB; in addition, the frequency of apnoeas and hypopnoeas per hour of TIB (AH/TIB) was calculated. Two people analysed the recordings. Each scorer analysed 25 portable monitor and 25 PSG recordings, and was blinded to the results obtained within the paired recording.Prevalence AHI≥10 = 42 subjects

Time between measurement of index test and reference standard: simultaneous recording by PSG and the portable monitoring device.</td></tr>
<tr><td>2×2 table</td><td></td><td>Reference standard +</td><td>Reference standard −</td><td>Total</td><td rowspan="4">Calculated by NGC</td></tr>
<tr><td></td><td>Index test +</td><td>45</td><td>1</td><td>46</td></tr>
<tr><td></td><td>Index test −</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td></td><td>Total</td><td>42</td><td>8</td><td>50</td></tr>
<tr><td>Statistical measures</td><td colspan="5"><u>Index text, portable sleep monitor (POLYMESAM), AHI/TIB ≥5</u>
Sensitivity 100%
Specificity 71.4%
Positive predictive value: 95.5%
Negative predictive value: 100%

Area under the curve, manually scored, (95% confidence interval) : not provided</td></tr>
<tr><td>Source of funding</td><td colspan="5">Not reported</td></tr>
<tr><td>Limitations</td><td colspan="5">Risk of bias: Serious. Inclusion/exclusion criteria not reported
Indirectness: Serious. Proxy AHI ≥10 used for reference standard</td></tr>
<tr><td>Comments</td><td colspan="5">Paper only provides totals and not TP, FP, FN, or TN.

These have been calculated using diagnostic calculation spreadsheet using sensitivity, specificity, PPV, NPV and totals.</td></tr>
</table>

Reference	**Masa 2013[297] (Masa 2013[300]; Masa 2011[298])**
Study type	Cross-sectional
Study methodology	Data source: suspected OSAHS patients in a multicentre study assigned to home and hospital protocols at random Recruitment: 'randomised'
Number of patients	n = 366 randomised, 348 completed protocol
Patient characteristics	Age, mean (SD): 48.7 (11.8) Gender (male to female ratio): 263/85 Ethnicity: not reported Setting: Home or hospital Country: Spain Inclusion criteria: patients between 18 and 70 years old, referred to pulmonary clinics at eight hospitals in Spain for suspected OSAHS, due to snoring, observed apnoeas, sleepiness (Epworth sleepiness scale >10) or morning fatigue. Patients with other suspected sleep disordered were not included Exclusion criteria: patients with severe heart disease, those who were unable to set up the home respiratory polygraphy instrument in a trial and those who refused to participate in the study
Target condition(s)	Sleep apnoea/ hypopnoea syndrome
Index test(s) and reference standard	Index test Home respiratory polygraphy (HRP): HRP (Breas SC20; Breas Medical AB, Mölnlycke, Sweden) measurements included: oxygen saturation (model 8000 J; Nonin Medical; Plymouth, MN, USA), airflow through a nasal cannula, and thoracic and abdominal movements measured by piezoelectric bands (Pro-Tech reference 1295; Respironics, Pittsburgh, PA, USA), which also measured body position. The intended use of the index test was to assess whether home polygraphy could reduce the requirement for in-hospital polysomnography. All patients were instructed on home use of the HRP device by a technician in the hospital setting before randomisation. Trained personnel from continuous positive airway pressure service companies in each hospital area, acting as transport companies, moved the HRP instruments from home to home. No additional assistance was provided by the transport services to help the patients set up the HRP devices. The same technician in each centre scored the raw data, following manual and automatic scoring protocols. In the manual scoring protocol, the total number of apnoeas and hypopnoeas was divided by the recording time, excluding 'invalid time' (time with a bad

Reference	Masa 2013[297] (Masa 2013[300]; Masa 2011[298])				
	signal that prevented scoring). For automatic scoring, the total number of apnoeas and hypopnoeas was divided by recorded time with no exclusions <u>Reference standard</u> In-hospital polysomnography (PSG) with an apnoea/hypopnoea index (AHI) of ≥15 diagnostic of OSAHS. PSG included electroencephalogram, electro-oculogram and electromyogram. Flow tracing was provided by a nasal cannula and thoracoabdominal motion by piezoelectric bands. Oxygen saturation was measured with a finger pulse oximeter. The PSG was analysed manually, according to the Rechtschaffen and Kales and the American Sleep Disorders Association 1992 criteria for sleep periods and arousals and according to the Spanish Sleep Network rule for respiratory scoring. Time between measurement of index test and reference standard: patients underwent PSG and HRP in a random order – once the first test was begun, the second test was scheduled for within the next 3 days. For PSG, an apnoea was defined as the absence of airflow (≥90% reduction) for ≥10 seconds and a hypopnoea as a discernible airflow or band reduction (≥30% and <90%) of ≥10 seconds duration with a ≥3% drop in oxygen saturation or final arousal. For HRP, apnoeas and hypopnoeas were defined in the same way, but without the final arousal criteria for hypopnoeas. For automatic scoring, apnoea/hypopnoea events were predicted with both flow reduction and desaturation detection, using a previously published regression equation. The number of apnoeas and hypopnoeas was divided by recording time for HRP and sleep time for PSG Prevalence: AHI≥5 = 90% (313 subjects), AHI≥15 = 75% (261 subjects)				
2×2 table All OSAS (AHI ≥ 5)		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test +	307	24	331	
	Index test −	6	11	17	
	Total	313	35	348	
2×2 table Moderate-severe OSAS (AHI ≥ 25)		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test +	175	7	182	
	Index test −	86	80	166	
	Total	261	87	348	

Reference	**Masa 2013[297] (Masa 2013[300]; Masa 2011[298])**
Statistical measures	Index text home respiratory polygraphy (manual scoring), AHI ≥5 Sensitivity 98% Specificity 31% Positive predictive value: not reported Negative predictive value: not reported Index text home respiratory polygraphy (manual scoring), AHI ≥25 Sensitivity 67 % Specificity 92% Positive predictive value: not reported Negative predictive value: not reported Area under the curve, manually scored, (95% confidence interval) All OSA (AHI≥5): not reported Moderate-severe (AHI≥15): 0.901 (0.867 – 0.936 Severe (AHI≥30): not reported
Source of funding	Instituto de Salud Carlos III (Fondo de Investigaciones Sanitarias, Ministerio de Sanidad y Consumo), Spanish Respiratory Society, Telefonica SA, Air Liquide and Breas Medical. Also the Ministerio de Ciencia e Innovación
Limitations	Risk of bias: Very serious. High differential rate of repeated recordings, with HRP repeated 52 times in 359 patients (once or twice per patient) compared with one repetition of PSG in nine patients. Unclear if study avoided inappropriate exclusions, unclear reasons for exclusion of three randomised participants who completed the protocol, and the test results could have been interpreted with knowledge of the other test results – the same technician scored both tests Indirectness: Serious proxy value AHI≥25 used for index test in moderate OSAHS population
Comments	Paper only provides totals and not TP, FP, FN, or TN. These have been calculated using diagnostic calculation spreadsheet using sensitivity, specificity, PPV, NPV and totals.

Reference	**Ng 2010[369]**
Study type	Cross-sectional
Study methodology	Data source: This study aimed to evaluate the diagnostic accuracy of Embletta portable diagnostic system (PDS, Medcare, Reykjavik, Iceland) for the screening of sleep apnoea in clinical practice. Recruitment: consecutive
Number of patients	n = 80 analysed
Patient characteristics	Age, mean (SD): 51.4 (11.9) Gender (male to female ratio): 63/17 Ethnicity: not reported Setting: laboratory Country: China Inclusion criteria: not reported Exclusion criteria: not reported Included participants had suspected obstructive sleep apnoea syndrome (OSAS). All participants with possible OSAHS had either self-reported daytime sleepiness that interfered with daytime function or two of the following symptoms: choking or gasping during sleep, daytime fatigue and impaired concentration.
Target condition(s)	Obstructive sleep apnoea syndrome
Index test(s) and reference standard	Index test Portable, three-channel airflow monitor (Embletta PDS): the PDS consisted of a pocket-sized digital recording device. It is a multi-channel screening tool that measures airflow through a nasal cannula connected to a pressure transducer, providing an AHI based on recording time. It also detects both respiratory and abdominal efforts through the effort sensor and can differentiate between obstructive and central events. The body position was detected by in-built sensors without confirmation by infrared camera. Technologists were not able to view the signals or correct sensor problems associated with the PDS during the course of the study. Respiratory events were scored when desaturation of at least 4% occurred in the absence of moving artefacts and irrespective of coexisting changes in snoring or heart rate. The PDS operates on battery power, with the internal memory storage of 16MB, which allows approximately 12 hours of data collection. The PDS default settings for apnoeas and hypopnoeas were used in this study. An apnoea was defined as a decrease in airflow by 80% of baseline for at least 10 seconds. The PDS default maximum apnoea duration was set at 80 seconds. A hypopnoea

Reference	**Ng 2010[369]**				
	was defined as a decrease in airflow by 50% of baseline for at least 10 seconds. The PDS default maximum hypopnoea duration was set at 100 seconds. The PDS AHI used for analysis was automatically analysed by the PDS software. Data were included in the analysis if the total recorded evaluation time of 4 hours or longer was obtained during the PDS study. Records of the index test and reference standard were analysed in a double-blinded fashion. <u>Reference standard</u> Laboratory polysomnography with no prespecified AHI, RDI or ODI for diagnosis of obstructive sleep apnoea syndrome: overnight diagnostic PSG was performed for every participant, recording electroencephalogram, electro-oculogram, submental electromyogram, bilateral anterior tibial electromyogram, ECG, chest and abdominal wall movement by inductance plethysmography, airflow measured by nasal pressure transducer and supplemented by an oral thermister, and finger pulse oximetry. Sleep stages were scored according to standard criteria by Rechtschaffen and Kales. Apnoea was defined as cessation of airflow for >10 seconds and hypopnoea as a reduction of airflow of ≥30% for >10 seconds plus an oxygen desaturation of >4 % or an arousal. Participants wore 2 nasal cannulae, with one for the PDS and the other for PSG. Prevalence: AHI≥5 = 66 subjects, AHI≥15 = 41 subjects Time between measurement of index test and reference standard: simultaneous sleep study with the portable airflow monitor and PSG				
2×2 table All OSA (AHI ≥ 5) Hospital RP		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test +	61	2	63	
	Index test −	5	12	17	
	Total	66	14	80	
2×2 table All OSA (AHI ≥ 15) Hospital RP		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test +	36	2	38	
	Index test −	5	37	42	
	Total	41	39	80	

Reference	**Ng 2010[369]**
Statistical measures	Index text, portable, three-channel airflow monitor AHI>5 Sensitivity 92.4% Specificity 85.7% Positive predictive value: 96.8% Negative predictive value: 70.6% Index text, portable, three-channel airflow monitor AHI>15 Sensitivity 88% Specificity 95% Positive predictive value: 94.7% Negative predictive value: 88.1% Area under the curve, manually scored, (95% confidence interval) All OSA (AHI≥5): 0.948 (CI not provided) Moderate-severe (AHI≥15): 0.985 (CI not provided) Severe (AHI≥30): not provided
Source of funding	The Respiratory Research Fund, The Chinese University of Hong Kong
Limitations	Risk of bias: Serious. Exclusion criteria not reported and 10/90 participants (11%) were excluded from analysis due to technical problems with the portable monitoring device Indirectness: None
Comments	Paper only provides totals and not TP, FP, FN, or TN. These have been calculated using diagnostic calculation spreadsheet using sensitivity, specificity, PPV, NPV and totals

Reference	**Pereira 2013[430]**
Study type	Cross-sectional
Study methodology	Data source: this study aimed to evaluate the combined diagnostic utility of a level III PM in diagnosis and exclusion of OSA, as compared with in-laboratory polysomnography (PSG) derived apnea hypopnea index (AHI) Recruitment: Consecutive

Reference	Pereira 2013[430]
Number of patients	N= 128 analysed
Patient characteristics	Age, mean (SD): 50(12.3) Gender (male to female ratio,): 84/47 Ethnicity: Not stated Setting: Sleep disorders clinic Country: Canada Inclusion criteria: the ability to apply the Level III monitoring equipment without supervision (after brief initial training) and a primary residence within 100 miles of the sleep clinic (for returning the PM equipment). Exclusion criteria: included known COPD, congestive heart failure, or uncontrolled asthma.
Target condition(s)	Obstructive sleep apnoea
Index test(s) and reference standard	Index test - They were asked to wear the Level III portable monitoring device (MediByte; Braebon Medical Corporation, Ottawa, ON) for 2 consecutive nights at home. The first night of recording was used in the analysis, with the second night as a back-up if recording from the first night did not provide sufficient data. The PM device consists of 2 inductance bands for thoracic and abdomen measurement, a nasal cannula pressure transducer airflow signal, finger pulse oximetry, and a body position sensor. Patients were given the option to either manually turn on the device before switching off the lights at night and turn off the device once awake in the morning, or to have the device start and stop automatically at predetermined times. Reference standard- Following completion of home testing, patients attended the Sleep Disorders Laboratory at Kingston General Hospital for a full overnight PSG. Recordings were conducted using Sandman Elite SD32+ digital sleep recording system (Natus [Embla]; Ottawa, ON), and included 4 EEG channels (C4-A1, C3-A2, O2-A1, F3-A2), 2 EOG channels (ROC-A1, LOC-A2), submental EMG, intercostal (diaphragmatic surface) EMG, bilateral anterior tibialis EMG, ECG, respiratory piezo bands (chest and abdomen), finger pulse oximetry, a vibration snore sensor, nasal pressure airflow, and oronasal thermocouple. PSG recordings were conducted as either a diagnostic study or, in the event of severe OSA, a split-night study. For split-night studies, the initial diagnostic period was followed by the introduction of treatment during the night, and only the diagnostic part of the recording was used for comparison. Prevalence: AHI≥5 = 116 subjects, AHI≥15 = 88 subjects, AHI≥30 = 56 subjects

Reference	**Pereira 2013[430]**				
2×2 table All OSA (AHI ≥5) Home RP		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test 1+	101	4	105	
	Index test 1−	15	8	23	
	Total	116	12	128	
2×2 table moderate-severe (AHI ≥15) Home RP		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test 1+	68	2	70	
	Index test 1−	20	38	58	
	Total	88	40	128	
2×2 table Severe (AHI ≥30) Home RP		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test 1+	28	5	33	
	Index test 1−	28	67	95	
	Total	56	72	128	
Statistical measures	Index test 1, portable sleep monitor, at home, AHI ≥5 (4% oxygen desaturation) Sensitivity 87% Specificity 67 % Positive predictive value: 96.2% Negative predictive value: 34.2% Index test 2, portable sleep monitor, at home, AHI ≥15 Sensitivity 77% Specificity 95% Positive predictive value: 97.1% Negative predictive value: 65.5% Index test 3, portable sleep monitor, at home, AHI ≥30 Sensitivity 50% Specificity 93% Positive predictive value: 84.8% Negative predictive value: 70.5 % Area under the curve, various PSG AHI cut-offs based on combination of ≥2 high scoring questionnaires and a PM RDI ≥10 events/h, (95% confidence interval) All OSA (AHI≥5): 0.773 (CI not provided)				

Reference	**Pereira 2013[430]**
	Moderate-severe (AHI≥15): 0.801 (CI not provided) Severe (AHI≥30): 0.716 (CI not provided)
Source of funding	The authors thank BRAEBON Medical Corporation for providing MediByte units for the purposes of the study, and the technologists at Kingston General Hospital Sleep Disorders Laboratory for assistance.
Limitations	Risk of bias: Serious risk of bias Indirectness: none
Comments	Paper only provides totals and not TP, FP, FN, or TN. These have been calculated using diagnostic calculation spreadsheet using sensitivity, specificity, PPV, NPV and totals.

Reference	**Polese 2013[443]**
Study type	Cross-sectional
Study methodology	Data source: The aim of our study was to evaluate the effectiveness of at home portable monitoring (PM) in elderly patients Recruitment: Consecutive
Number of patients	N= 43 analysed
Patient characteristics	Age, mean (SD) = 70(5) Gender (male to female ratio): 44/56 (%) Ethnicity: Not stated Setting: Sleep institute Country: Brazil

Reference	**Polese 2013[443]**				
	Inclusion criteria: included those aged ≥65 years (the World Health Organization's definition of elderly), both genders, and with suspected OSAHS, i.e., complaints of daytime sleepiness, loud snoring, and apnea witnessed by a bed partner Exclusion criteria: patients with a suspicion of other sleep disorders, those who had previously undergone PSG or treated for OSAHS, patients with severe or unstable medical illnesses, those who are on oxygen therapy, and those who are using hypnotics, alcohol, or recreational drugs.				
Target condition(s)	Obstructive sleep apnoea				
Index test(s) and reference standard	Index test - The type 3 portable device used was the Stardust II® (Philips Respironics, Inc., Murrysville, PA, USA), which has been shown to be capable of diagnosing OSAS in a non-elderly population. The Stardust records include SpO2 (finger sensor), heart rate (finger sensor), airflow (nasal pressure), respiratory effort (belt with piezoelectric sensor set at the lower sternum), and body position (device positioned at the lower sternum). Data are collected and stored on internal memory in the device. The data are then downloaded to a computer for automated analysis by the host software (Stardust Host Software, Philips Respironics, Inc., USA). A trained PSG technician applied the PM and sensors used for the PSG recording during the overnight PSG in the sleep lab. A research assistant instructed the patients how to use PM at home. The explanation included verbal and written instructions to illustrate the correct hook-up of the PM and included diagrams and a brief practical demonstration. During training, patients were asked to indicate “lights out” and “lights on” and any time during the night he/she remained awake for more than 15 min. Reference standard - Laboratory polysomnography - Full-night PSG (Embla® S7000, Embla Systems, Inc.,Broomfield, CO, USA) was performed by a trained technician. The PSG montage included electroencephalogram, electrooculogram, electromyogram (submental region and bilateral anterior tibialis muscle), airflow (nasal pressure and thermistor), respiratory effort of thorax and abdomen (inductance plethysmography), oxyhemoglobin saturation (SpO2), snoring, body position, and video monitoring. Prevalence (Home RP): AHI ≥ 5 = 93% (36 subjects), AHI ≥ 30 = 72% (28 subjects); Prevalence (Hospital RP) AHI ≥5 = 93% (35 subjects), AHI≥30 = 72% (27 subjects)				
2×2 table All OSA (AHI ≥5) Home RP		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test 1+	32	2	35	
	Index test 1−	4	1	5	
	Total	36	3	39	
2×2 table Severe (AHI ≥30)		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test 1+	22	2	25	

Reference	**Polese 2013[443]**				
Home RP	Index test 1−	6	9	14	
	Total	28	11	39	
2×2 table All OSA (AHI ≥5) Hospital RP		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test 1+	35	3	38	
	Index test 1−	0	0	0	
	Total	35	3	38	
2×2 table Severe (AHI ≥30) Hospital RP		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test 1+	24	4	28	
	Index test 1−	3	7	10	
	Total	27	11	38	
Statistical measures	Index test 1, portable sleep monitor, at home, AHI ≥5 Sensitivity 90% Specificity 30% Positive predictive value: 90% Negative predictive value: 60% Index test 2, portable sleep monitor, at home, AHI ≥30 Sensitivity 80% Specificity 80% Positive predictive value: 70% Negative predictive value: 15% Index test 3, portable sleep monitor, at hospital, AHI ≥5 Sensitivity 100% Specificity 0% Positive predictive value: 1% Negative predictive value: 0% Index test 4, portable sleep monitor, at hospital, AHI ≥30 Sensitivity 90% Specificity 68% Positive predictive value: 71% Negative predictive value: 0.1%				

Reference	**Polese 2013[443]**
	Area under the curve, manually scored, (95% confidence interval) - Home All OSA (AHI≥5): 0.83 (CI not provided) Moderate-severe (AHI≥15): 0.85 (CI not provided) Severe (AHI≥30): 0.85 (CI not provided) Area under the curve, manually scored, (95% confidence interval) - Hospital All OSA (AHI≥5): 0.93 (CI not provided) Moderate-severe (AHI≥15): 0.99 (CI not provided) Severe (AHI≥30): 0.90 (CI not provided)
Source of funding	Funding not reported
Limitations	Risk of bias: Serious risk of bias. Complete loss of data 9.3% of PM home recordings. In the PM home group, partial data loss was observed in 44 % of the recordings: six recordings showed a partial loss of pulse oximetry, airflow signal loss in eight recordings, and chest signal band loss in five patients. The data from these recordings were included in the analysis because more than 75 % of each recording was acceptable. Indirectness: none
Comments	Paper only provides totals and not TP, FP, FN, or TN. These have been calculated using diagnostic calculation spreadsheet using sensitivity, specificity, and totals. PPV and NPV values reported in the paper appear to be very inaccurate so these values were not used in the analysis.

Reference	**Reichert 2003[464]**
Study type	Cross -sectional
Study methodology	Data source: Fifty-one consecutive adults referred to the sleep lab for suspicion of OSA underwent one night of in-lab, simultaneous recording of PSG and NovaSom QSG in addition to using the NovaSom QSG at home for three nights. Recruitment: consecutive

Reference	**Reichert 2003[464]**
Number of patients	n = 51 recruited, 44 analysed in-laboratory and 45 analysed at home and in-laboratory
Patient characteristics	Age, mean (range): 52 (30-83) Gender (male to female ratio): 38/13 Ethnicity: not reported Setting: laboratory and home Country: USA Inclusion criteria: not reported Exclusion criteria: not reported Adults were referred to the sleep laboratory by a large pool of community physicians due to a clinical suspicion of OSA, based on symptoms including snoring, witnessed apnoea and excessive daytime sleepiness, and they were scheduled for overnight in-lab polysomnography.
Target condition(s)	Obstructive sleep apnoea
Index test(s) and reference standard	Index test Portable, five-channel home diagnostic system (NovaSom QSG): participants performed home NovaSom QSG study either before or after their in-lab study. To minimise order bias, half of the home recordings were performed before in-lab recordings and half were performed after in-lab recordings, according to the order of referral to the centre. They were instructed to use the diagnostic system at home for three nights but received no instructions on how to use it; Instructions for use, a Quick Guide and an instructional video were provided with the diagnostic system, in addition to a 24 hour helpline. The NovaSom QSG, manufactured by Sleep Solutions Incorporated, measures nasal and oral airflow (using sound), oxygen saturation, heart rate, respiration effort and snoring sound intensity. The system consists of a bedside unit, a patient module (worn on the patient's wrist) and three body sensors: airflow, finger oximeter and respiratory effort. It is self-administered and used unattended in the home to record three nights of data. The effort sensor is thin Tygon tubing placed around the chest and is connected to a pressure transducer in the patient module. The finger sensor is a Nonin Adult Flexi-form 7000A. Testing was unattended and self-administered by the participant at home. The system used voice alerts to wake the patient if any of the sensors became dislodged during the night. The NovaSom QSG does not differentiate between wake and sleep, so the AHI measurement is based on total recording time as opposed to total sleep time. The diagnostic system scoring was automated, using proprietary algorithms. The technologist was blinded to the NovaSom QSG signal both during recording and scoring of the data. Some of the in-lab NovaSom QSG recordings were interrupted due to a split night protocol.

Reference	**Reichert 2003[464]**
	Reference standard Laboratory polysomnography (PSG) with a prespecified clinical AHI cut-off ≥15: PSG included two channels of electroencephalogram, electro-oculogram, submentalis electromyogram, electrocardiography, anterior tibialis EMG, diaphragmatic EMG, microphone (snoring sounds), end tidal CO_2, nasal-oral airflow (thermocouple), abdominal and thoracic respiration using piezo sensors, and oximetry (Novametrix), all processed through a Grass polygraph and recorded by a Sandman Diagnostics System. Each PSG was staged for sleep according to the Rechtschaffen and Kales criteria by a trained, blinded technologist. Respiratory events from the PSG recording were manually scored by the technologist. For both PSG and the NovaSom QSG, an apnoea was defined as cessation of airflow for 10 seconds or longer and hypopnoea was defined as ≥50% reduction in airflow for 10 seconds or longer accompanied by a ≥2% decrease in oxygen haemoglobin saturation. Some of the PSG recordings were interrupted due to a split night protocol (40/44 in-lab recordings). Prevalence: AHI ≥15 = 20 subjects Time between measurement of index test and reference standard: simultaneous in-lab PSG and NovaSom QSG. Home NovaSom QSG was also performed within 7 days of the lab test.

2×2 table moderate-severe OSAS (AHI ≥ 15)

	Reference standard +	Reference standard −	Total	Calculated by NGC
Index test 2+	20	2	22	
Index test 2 −	1	21	22	
Total	21	23	44	

Statistical measures	Index text , portable, five-channel diagnostic system in-lab (automated scoring) , AHI ≥15 Sensitivity 95% Specificity 91% Positive predictive value: 91% Negative predictive value: 96% Area under the curve, manually scored, (95% confidence interval) : not reported
Source of funding	Financial support was received from the Sequoia Hospital Pulmonary Research Fund
Limitations	Risk of bias: Serious. Inclusion/exclusion criteria not reported, and unclear whether the index test was interpreted without knowledge of the reference standard. Approximately 12% missing data for the home and in-laboratory testing, and 14% for the in-laboratory testing Indirectness: None
Comments	Paper only provides totals and not TP, FP, FN, or TN. These have been calculated using diagnostic calculation spreadsheet using sensitivity, specificity, PPV, NPV and totals.

Reference	**Rofail 2010[475]**
Study type	Cross-sectional
Study methodology	Data source: All patients had laboratory PSG and 2 sets of 3 consecutive nights on each device; nasal airflow (Flow Wizard, DiagnoseIT, Australia) and oximetry (Radical Set, Masimo, USA) at home in random order Recruitment: consecutive
Number of patients	n = 105 recruited, 98 completed the protocol with 92 analysed over three nights, 72 analysed over first night
Patient characteristics	Age, mean (SD): 46.0 (11.7) Gender (male to female ratio, %): 77/23 (total numbers unclear) Ethnicity: 89.5% Caucasian (total numbers unclear) Setting: laboratory and home Country: Australia Inclusion criteria: not reported Exclusion criteria: patients with complex, unstable medical conditions, such as congestive heart failure, severe chronic obstructive pulmonary disease, interstitial lung disease, dependency on home oxygen, severe obesity (BMI over 45 kg/m^2), neuromuscular disorder, inability to apply the diagnostic device (e.g. severe osteoarthritis), unstable psychiatric illness and/or history of current or previous drug and alcohol dependence including those in drug and alcohol rehabilitation, shift workers, known history of other sleep disorders, patients unable to understand the patient information sheets and those enrolled on other clinical research studies. In addition, those who lived in remote areas (>40km away from the study site), and those who presented when all of the available nasal flow monitors and oximeters were in use could not be recruited for the home study. Study participants were referred to the Sleep Disorders Clinic for evaluation of possible OSA.
Target condition(s)	Obstructive sleep apnoea
Index test(s) and reference standard	Index tests Single-channel, nasal airflow device, RDI (Flow Wizard, DiagnoseIT, Sydney, Australia): The Flow Wizard recorded nasal airflow pressure via nasal cannulae. Automated nasal flow RDI calculations were based on the artefact-free flow recording time. Respiratory

Reference	Rofail 2010[475]
	disturbances included apnoeas, defined as a decrease in the amplitude of the airflow signal by ≥90% for ≥10 seconds, and hypopnoeas, a reduction in the amplitude of the respiratory signal ≥50% for ≥10 seconds. The recordings were automatically scored without manual editing. In the home, two types of nasal cannula were used: the Comfort PIus Soft Tip adult nasal cannula (Wedmed, Arizona, USA) was used in the first 53 patients, and the Pro-Flow adult nasal cannula (ProTech, Washington, USA) was used in the following 52 patients. Single-channel oximeter, ODI (Radical Set, Masimo, CA, USA): The Radical Set was set to a short (2-second) averaging time and a high sampling rate (80 Hz). The ODI (3%) was calculated as the number of desaturation events ≥3% divided by the total time in bed. Download 2001 v. 2.6.0 (Stowood Scientific Instruments, Oxford, UK) was used to analyse the tracing. The recordings were automatically scored without manual editing. For nasal flow and oximetry, the data were included in the analysis and regarded as sufficient if ≥3 hours of good quality recording was obtained over one study night and ≥6 hours over all three nights combined. For nasal flow, the duration of good quality recording was defined as the total recording duration minus poor quality signal time (defined by very low mean maximum pressure for 20 breaths and prolonged loss of flow signal >2 minutes as per software algorithm). For oximetry, good quality recording duration was the analysis duration minus artefact time as per the software algorithm. The data reported for all three nights was the total number of events divided by total good quality time over the three nights. <u>Reference standard</u> Laboratory polysomnography (PSG) with a prespecified AHI of ≥5 diagnostic of OSA: computerised, attended full PSG recordings were performed (Alice 5, Respironics, Murrysville PA, USA) and included electroencephalography, electro-oculography, and submental and tibialis anterior electromyography for sleep staging according to Rechtschaffen and Kales criteria. Also, thoracic and abdominal piezoelectric respiratory movement sensors, oxygen saturation, nasal pressure via adults nasal cannulae (Pro-Tech, Washington, USA), body position, snoring, and electrocardiogram were monitored. Apnoeas were defined as complete cessation of airflow and hypopnoeas were defined as flow reduction >50% associated with either a 3% desaturation or an arousal. The PSG recordings were scored independently by trained sleep technicians blinded to the portable monitor results. PSG recordings were included in the analysis and regarded as sufficient if ≥3 hours of total sleep time was obtained. Time between measurement of index test and reference standard: home and in-laboratory recordings were performed within an 8-week period. The patients performed home recordings for two consecutive 3-night sequences. The two sequences, performed in random order, were three nights on the nasal flow monitor and three nights on the oximeter. They were instructed to use the device for a minimum of 6 hours per night. The two sequences conducted at home and the in-laboratory PSG were performed in random order. The patients, research staff, and their physician were blinded to all the results until the completion of all components of the study. Prevalence (AHI ≥ 5) = 70.5% (51 subjects)

Reference	**Rofail 2010[475]**				
2×2 table aAll OSAS (ODI ≥ 7)		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test 1+	32	4	36	
	Index test 1−	19	18	36	
	Total	51	22	72	
Statistical measures	Index test, single-channel oximeter, automatic scoring over first night, ODI (3%) >7 Sensitivity 63% Specificity 83% Positive predictive value: Not reported Negative predictive value: Not reported Area under the curve, manually scored, (95% confidence interval) : not reported				
Source of funding	Departmental research support from Respironics, Resmed, Covidien, Fisher-Paykel, Sanofi-Aventis, Actelion, Impax, DiagnoseIT, and Arena has consulted for and has financial interests in DiagnoseIT.				
Limitations	Risk of bias: Serious. Unclear if all study exclusions appropriate as part of study exclusion criteria, and there were missing data for 27% of first night analyses, as a proportion of those who completed the full protocol. Indirectness: serious proxy ODI>7 was used for index test				
Comments	Paper only provides totals and not TP, FP, FN, or TN. These have been calculated using diagnostic calculation spreadsheet using sensitivity, specificity, PPV, NPV and totals				

Reference	**Ryan 1995[490]**
Study type	Cross-sectional
Study methodology	Data source: patients referred to a district general hospital sleep clinic were recruited. After initial clinical assessment, overnight pulse oximetry measurements were performed, followed by full polysomnography at the regional laboratory. Recruitment: ‘the first 100 participants who satisfied inclusion criteria’
Number of patients	n = 69 analysed

Reference	Ryan 1995[490]
Patient characteristics	Age, mean (SD): 48 (12) Gender (male to female ratio): 57/12 Ethnicity: not reported Setting: Home and laboratory Country: UK Inclusion criteria: not reported Exclusion criteria: Under 16 years of age, had an awake baseline oxygen saturation of 90% or less, or known cardiorespiratory, neuromuscular or skeletal disease
Target condition(s)	Sleep apnoea/hypopnoea syndrome
Index test(s) and reference standard	Index test Oximetry device: overnight home pulse oximetry with a finger flexiprobe. This system samples every second but prints out the value at each 10 second interval. The oximetry trace was read by two respiratory physicians unaware of the clinical details. The number of desaturations was counted manually. The physicians were a consultant and a senior registrar with two or three years' experience of running a respiratory sleep clinic. Using the British Thoracic Society oximetry criteria, a diagnosis of 'SAHS positive' or 'SAHS negative' was made. Reference standard Laboratory polysomnography (PSG) with a prespecified AHI of ≥15 diagnostic of sleep apnoea/hypopnoea syndrome. PSG included oximetry (Ohmeda pulse oximeter 3700), respitrace recordings of abdominal and chest wall movements (Airshield impedance apnoea monitor), video recording of respiratory movements (Cannon vision E video camera with Akai recorder), two lead EEG, EMG, ECG and nasal and oral airflow measurements (Edentec airflow thermistor and PK Morgan Capnograph 901-MK2) using the Neuroscience Sleepmaster system and software version X5.2D. Apnoeas were diagnosed on the basis of no airflow for at least 10 seconds and a desaturation of >4% in the following 30 seconds. Hypopnoeas were defined as reduction in chest wall movement (>25%), reduced abdominal wall movement (>15%), and paradoxical movement with airflow reduction of >25%. The criteria of Rechtschaffen and Kales were used for sleep staging. These and respiratory events were computer analysed with manual editing. Time between measurement of index test and reference standard: not reported Prevalence AHI ≥15 = 32 subjects

Reference	**Ryan 1995[490]**				
2×2 table Moderate – severe (AHI ≥ 15)		Reference standard +	Reference standard −	Total	TP and TN reported in the paper
	Index test +	10	0	10	
	Index test −	22	37	59	
	Total	32	37	69	
Statistical measures	Index text oximetry device: overnight home pulse oximetry, with AHI ≥15 Sensitivity 31% Specificity 100% Positive predictive value: 100% Negative predictive value: 63% Area under the curve, manually scored, (95% confidence interval): not reported				
Source of funding	Not reported				
Limitations	Risk of bias: Very serious. Enrollment method unclear; unclear if all study exclusions appropriate, and test results could have been interpreted with knowledge of the other test results Indirectness: None				
Comments	Paper provides totals and not TP and TN. FN and FP have been calculated using diagnostic calculation spreadsheet using sensitivity, specificity, TP, TN, PPV, NPV and totals.				

Reference	**Wiltshire 2001[590]**
Study type	Cross-sectional
Study methodology	Data source: patients were referred from ear, nose, and throat surgeons, primary-care physicians, and other chest physicians for assessment of suspected SAHS using full polysomnography. Recruitment: 100 consecutive patients were studied
Number of patients	84 analysed

Reference	**Wiltshire 2001[590]**				
Patient characteristics	Age, mean (SD): Gender (male to female ratio, %): Ethnicity: Not stated Setting: Not stated Country: UK Inclusion criteria: Patients with suspected OSAHS Exclusion criteria: not stated				
Target condition(s)	Obstructive sleep apnoea				
Index test(s) and reference standard	Index test – Home oximetry. The oximeters used in this study were Biox 3740 (Ohmeda UK). For the home and laboratory, studies oximeters were identical, including the software version (version 9) and the default settings. Signal averaging defaulted to 6 s in this software. Finger- clip oximeter probe was used in all studies. These oximeters have a memory storage capability of 8 h, storing a data point every 12 s. this memory capability was used in the home studies and some of the laboratory studies for comparison. Recordings online in the laboratory studies recorded a data point every 2 s. These oximeters also have pulse waveforms that provide an indication of signal strength. It was not possible to evaluate whether good signal strength was obtained in the home studies. In the laboratory studies, the pulse waveform was monitored throughout the night to ensure good quality signal strength. Reference standard – laboratory polysomnography. All underwent full polysomnography within 3 days of the home studies. Patients underwent foll polysomnographic study that included EEG, electrooculography, electromyography, and ECG recordings, thoraco abdominal and nasal-oral air flow measurements and pulse oximetry. The signals were recorded online using the SleepLab system. Video sound recording was made throughout the night. Patients went to bed at their normal bedtime; if they consumed alcohol on home study night, they were allowed to consume similar quantities on the night of the study. Prevalence AHI ≥10 = 32 subjects; AHI ≥15 =23 subjects				
2×2 table moderate-severe (ODI ≥10) Home oximetry		Reference standard +	Reference standard −	Total	TP, TN, FN were provided by the paper FP were calculated by NGC
	Index test 1+	13	0	13	
	Index test 1−	19	52	71	
	Total	32	52	84	

Reference	**Wiltshire 2001[590]**				
2×2 table moderate-severe (ODI ≥15) Home oximetry		Reference standard +	Reference standard −	Total	TP, TN, FN were provided by the paper FP were calculated by NGC
	Index test 1+	8	0	8	
	Index test 1−	15	61	76	
	Total	23	61	84	
Statistical measures	Index test 1, portable sleep monitor, at home, ODI ≥10 Sensitivity – 41% Specificity – 100 % Positive predictive value: not reported Negative predictive value: not reported Area under the curve, manually scored, (95% confidence interval): not reported Index test 2, portable sleep monitor, at home, ODI ≥15 Sensitivity – 35% Specificity – 100 % Positive predictive value: not reported Negative predictive value: not reported Area under the curve, manually scored, (95% confidence interval): not reported				
Source of funding	Funding not stated				
Limitations	Risk of bias: serious risk of bias Indirectness: Serious indirectness, Proxy ODI>10 was used for index testin mild OSAHS population				
Comments	Paper only provides totals and TP, FN and TN. FP have been calculated using diagnostic calculation spreadsheet using sensitivity, specificity, TP,FN,TN, PPV, NPV and totals.				

Reference	**Xu 2017[597]**
Study type	Cross-sectional
Study methodology	Data source: Eighty Chinese adults underwent overnight, unattended home sleep apnea testing (HSAT) with the Nox-T3 portable monitor followed by an overnight in-laboratory polysomnogram (PSG) with simultaneous portable monitor recording Recruitment: not reported
Number of patients	n = 80 analysed
Patient characteristics	Age, mean (SD): 47 (14) Gender (male to female ratio, %): 76/24 Ethnicity: not reported Setting: laboratory and home Country: China Inclusion criteria: not reported Exclusion criteria: no telephone access or inability to return for follow-up; prior diagnosis of central sleep apnoea/Cheyne-Stokes respiration, obesity hypoventilation syndrome, narcolepsy, rapid eye movement behaviour disorder, chronic obstructive pulmonary disease, or heart failure; shift work; regular jet lag or irregular work schedules by history over the past 3 months; supplemental oxygen therapy (daytime or nocturnal); or a clinically unstable medical condition as defined by a change in medications in the previous month, or a new medical diagnosis in the previous 2 months (e.g. myocardial infarction, active infection, thyroid disease, depression or psychosis, cirrhosis, surgery, or cancer). Study participants were referred for evaluation of OSA and were between the ages of 18 and 80 years with no previous testing or treatment for OSA.
Target condition(s)	Obstructive sleep apnoea
Index test(s) and reference standard	Index test Portable sleep monitor, AHI (Nox-T3, Nox Medical Inc. Reykjavik, Iceland): the Nox-T3 recorded nasal pressure, rib cage and abdominal movement by inductance plethysmography, snoring, body position, activity, and heart rate and oxygen saturation by pulse oximetry. Participants in the home study came to the sleep centre to receive instructions on how to perform the recording. During the session, a trained sleep technologist demonstrated how to apply the sensors and the participant was then asked to apply the sensors.

Reference	Xu 2017[597]
	After the technician confirmed proper placement, the sensors were removed, and the participant reapplied the sensors at home just prior to bedtime. During in-laboratory testing, the sleep technologist applied the portable monitor sensors and initiated the recording. Separate sensors were used for the simultaneous portable monitor and PSG recordings. Therefore, participants wore two sets of nasal cannula, two sets of rib cage and abdominal belts, and two pulse oximeters in the laboratory. A successful home monitoring study required at least three hours of recording containing the oxygen saturation and at least one of the respiratory signals (airflow, rib cage movement, abdominal movement). If the initial home monitoring was unsuccessful, the participant took a portable monitor home after the PSG and undertook another home study. If the second attempt was unsuccessful, the home study was not repeated. The quality of the home study was assessed by automated analysis of the signal quality for oxygen saturation, airflow, abdominal movement, and thoracic movement. The automated analysis scores artefacts when the signal is absent or deemed to be invalid. Analysis start- and stop time on the portable monitor recordings were manually determined based on the participants' responses on a morning questionnaire and the activity signal on the recording. The scorer was blinded to whether the portable monitor recording was performed at home or in the laboratory and to a particular participant's PSG results. The portable monitor recordings were initially scored automatically using Noxturnal software. The software programme defined apnoeas as ≥90% reduction in airflow from baseline for at least 10 seconds. Obstructive apnoeas were defined as an apnoea associated with respiratory effort and central apnoeas were defined as an apnoea during which respiratory effort was absent. Mixed apnoeas were defined as an apnoea during which respiratory effort was initially absent but appeared during the latter part of the event. Hypopnoeas were defined as a ≥30% reduction in a respiratory signal for ≥10 seconds associated with a ≥4% reduction in oxygen saturation. The recordings were then manually edited by an experienced PSG technologist with the aid of the software programme using 2012 American Academy of Sleep Medicine scoring criteria. The same start and stop time selected for the automatic scoring was used for the manually edited scoring. Two separate manually edited scorings were performed using different definitions for hypopnoea: the same criteria used for automatic scoring; hypopnoeas defined by a ≥30% reduction in respiratory signal for at least 10 seconds associated with a ≥3% reduction in oxygen saturation. When the portable monitor recording for nasal pressure was absent or not able to be scored throughout the recording or during portions of the recording, the flow signal derived from the rib cage and abdominal respiratory inductance plethysmography signals were used for the scoring. The AHI on the Nox-T3 recordings was calculated as the average number of apnoeas and hypopnoeas per hour of analysis time. Reference standard Laboratory polysomnography (PSG) with no prespecified diagnostic AHI, RDI or ODI: PSG was performed according to the American Academy of Sleep Medicine recommendations. The following signals were recorded: electroencephalogram; bilateral electro-oculogram; chin muscle electromyogram; oronasal thermistor; nasal pressure; rib cage and abdominal movement; electrocardiogram; snoring; body position; bilateral anterior tibialis electromyograms; heart rate and oxygen saturation by pulse oximetry. Using American Academy of Sleep Medicine 2012 scoring criteria, PSG was scored manually with the aid of computer software by an experienced sleep technologist without knowledge of the results of the portable monitor recordings. Apnoeas were scored when there was ≥90% reduction in airflow from baseline for ≥10 seconds on the oronasal thermistor signal. The same criteria used to identify obstructive, central and mixed apnoeas on the portable monitor recordings were used to score those events on PSG. Two separate PSG scorings were performed using different definitions for hypopnoea: events with ≥30% reduction in airflow from baseline for ≥10 seconds accompanied by ≥4% oxygen desaturation; events with ≥30% reduction in airflow from baseline for ≥10 seconds associated with ≥3%

Reference	**Xu 2017[597]**				
	reduction in oxygen saturation and/or an arousal. AHI on PSG was calculated as the average number of apnoeas and hypopnoeas per hour of sleep. Time between measurement of index test and reference standard: laboratory PSG and portable monitoring were performed simultaneous and within 1 week after the portable sleep monitoring at home. Prevalence (Home RP): AHI ≥5 = 83% (64 subjects), AHI ≥15 = 55% (42 subjects), AHI ≥30 = 39% (30 subjects), Prevalence (Hospital RP): AHI ≥5 = 84% (64 subjects), AHI ≥15 = 55% (42 subjects), AHI ≥5 = 40% (30 subjects)				
2×2 table All OSA (AHI ≥5) Home RP		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test 1+	61	4	65	
	Index test 1−	3	9	12	
	Total	64	13	77	
2×2 table moderate-severe (AHI ≥15) Home RP		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test 1+	39	5	44	
	Index test 1−	3	30	33	
	Total	42	35	77	
2×2 table Severe (AHI ≥30) Home RP		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test 1+	19	3	22	
	Index test 1−	11	44	55	
	Total	30	47	77	
2×2 table All OSA (AHI ≥5) Hospital RP		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test 1+	62	3	65	
	Index test 1−	2	9	11	
	Total	64	12	76	
2×2 table Moderate-severe OSA (AHI ≥5) Hospital RP		Reference standard +	Reference standard −	Total	Calculated by NGC
	Index test 1+	42	2	44	
	Index test 1−	0	32	32	
	Total	42	34	76	
		Reference standard +	Reference standard −	Total	Calculated by NGC

Reference	**Xu 2017[597]**				
2×2 table severe OSA (AHI ≥5) Hospital RP	Index test 1+	29	1	30	
	Index test 1−	1	45	46	
	Total	30	46	76	
Statistical measures	Index test 1, portable sleep monitor, at home, AHI ≥5 (4% oxygen desaturation) Sensitivity 95% Specificity 69% Positive predictive value: 94% Negative predictive value: 75% Index test 2, portable sleep monitor, at home, AHI ≥15 Sensitivity 93% Specificity 85% Positive predictive value: 89% Negative predictive value: 91% Index test 3, portable sleep monitor, at home, AHI ≥30 Sensitivity 63% Specificity 93% Positive predictive value: 86% Negative predictive value: 80% Index test 4, portable sleep monitor, in-laboratory, AHI ≥5 (4% oxygen desaturation) Sensitivity 97% Specificity 75% Positive predictive value: 95% Negative predictive value: 82% Index test 4, portable sleep monitor, in-laboratory, AHI ≥15 Sensitivity 100% Specificity 94% Positive predictive value: 95% Negative predictive value: 100% Index test 4, portable sleep monitor, in-laboratory, AHI ≥30 Sensitivity 97%				

Reference	Xu 2017[597]
	Specificity 98% Positive predictive value: 97% Negative predictive value: 98% Area under the curve, manually scored, (95% confidence interval): Home – not reported Area under the curve, manually scored, (95% confidence interval): Hospital – not reported
Source of funding	Phillips Respironics Foundation and grants from the Ministry of Science and Technology and Beijing Municipal Science and Technology Commission
Limitations	Risk of bias: Serious. Unclear if all study exclusions appropriate as part of study exclusion criteria Indirectness: None
Comments	Paper only provides totals and not TP, FP, FN, or TN. These have been calculated using diagnostic calculation spreadsheet using sensitivity, specificity, PPV, NPV and totals.

Appendix E: Clinical evidence table for test and treat study

Study	Conventional Polysomnography Is Not Necessary for the Management of Most Patients with Suspected Obstructive Sleep Apnea trial: Corral 2017[93]
Study type	RCT (Patient randomised; Parallel)
Number of studies (number of participants)	1 (n=430)
Countries and setting	Conducted in Spain; Setting: 12 tertiary hospitals
Line of therapy	1st line
Duration of study	Intervention + follow up: 6 months follow up
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Moderate-severe: n/a
Subgroup analysis within study	Not applicable: n/a
Inclusion criteria	Patients between 18 and 70 years of age who were referred for pulmonary consultations because of suspected OSA at 12 tertiary hospitals in Spain (see online supplement). Other inclusion criteria were (1) snoring or sleep apnoea's observed by a partner, (2) ESS greater than or equal to 10, and (3) absence of clinical suspicion of any other sleep pathology that could cause daytime sleepiness (e.g., narcolepsy).
Exclusion criteria	1) psychophysical inability to complete the questionnaires; (2) documented structural or coronary cardiopathy that was not controlled by medical treatment; (3) Cheyne-Stokes syndrome; (4) patients with uvulopalatopharyngoplasty, which can prevent effective CPAP treatment; (5) very severe nasal obstruction, which can prevent CPAP treatment; and (6) an inability to provide informed consent.
Recruitment/selection of patients	Consecutive
Age, gender and ethnicity	Age - Median (IQR): 50 (16). Gender (M:F): male 70.5%. Ethnicity: not stated
Further population details	1. BMI: BMI >/=30 (median (IQR) = 30.7(7.3). 2. Co-existing conditions: T2DM (overall - 9.3% (Home RP - 10.6%; Polysomnography - 8%)). 3. Gender: Not applicable (70.5% male). 4. High risk occupation group: Not stated / Unclear 5. Race: Not stated / Unclear 6. Sleepiness: ESS >9 (Median (IQR) - 13(5)).
Indirectness of population	No indirectness
Interventions	(n=218) Intervention 1: Home respiratory polygraphy. HRP (Embla-Embletta; Natus,Pleasanton, CA) measurements included oxygen saturation, airflow through nasal pressure, and thoracic and abdominal movements measured by piezoelectric

	bands. The patients transported the device to their homes with a prior detailed explanation and functional test device provided by a technician in the hospital setting. When the patients returned the device the following day, the raw data files were transmitted to a computer and scored manually, excluding artifact periods. PSG was performed in patients with invalid HRP tests after several repetitions, and the subsequent cost was added to the HRP arm. Duration 6 months. Concurrent medication/care: A sleep physician specialist at each centre (always the same individual) made the therapeutic decision based on a standardized set of variables, including clinical symptoms and results from HRP or PSG, using the same website. The treatment decision was guided using the Spanish Sleep Network guidelines. The sleep physician recommended CPAP treatment in the case of a respiratory event index (REI) greater than or equal to 5 for HRP or an AHI greater than or equal to 5 for PSG with significant clinical symptoms (i.e., ESS >12), potentially secondary to OSA or previous cardiovascular diseases, and an REI or an AHI greater than or equal to 30, with clinical symptoms having less importance. Non-CPAP treatment included only correct sleep hygiene and a hypocaloric diet. Indirectness: No indirectness Further details: 1. Intervention type: Electronic (The sleep physician recommended CPAP treatment in the case of a respiratory event index (REI) greater than or equal to 5 for HRP or an AHI greater than or equal to 5 for PSG with significant clinical symptoms (i.e., ESS >12),). (n=212) Intervention 2: Hospital respiratory polygraphy - Hospital polysomnography. We used standard protocols to perform PSGs and analyse the results. PSG and HRP studies with less than 3 recorded hours were repeated on two other occasions, and the costs were included in the overall cost calculation. For PSG, apnoea was the absence of flow lasting 10 seconds or more, and hypopnea was a discernible decrease in flow lasting 10 seconds or more with oxygen desaturation (>3%) or arousal. For HRP, the definitions were the same but without the final arousal criteria. Duration 6 months. Concurrent medication/care: A sleep physician specialist at each centre (always the same individual) made the therapeutic decision based on a standardized set of variables, including clinical symptoms and results from HRP or PSG, using the same website. The treatment decision was guided using the Spanish Sleep Network guidelines. The sleep physician recommended CPAP treatment in the case of a respiratory event index (REI) greater than or equal to 5 for HRP or an AHI greater than or equal to 5 for PSG with significant clinical symptoms (i.e., ESS >12), potentially secondary to OSA or previous cardiovascular diseases, and an REI or an AHI greater than or equal to 30, with clinical symptoms having less importance. Non-CPAP treatment included only correct sleep hygiene and a hypocaloric diet. Indirectness: No indirectness Further details: 1. Intervention type: Electronic (The sleep physician recommended CPAP treatment in the case of a respiratory event index (REI) greater than or equal to 5 for HRP or an AHI greater than or equal to 5 for PSG with significant clinical symptoms (i.e., ESS >12)).

Funding	Funding not stated

RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: HOME RESPIRATORY POLYGRAPHY versus HOSPITAL POLYSOMNOGRAPHY

Protocol outcome 1: Quality of life at >1 month
- Actual outcome for Moderate-severe: Change in quality of life EQ5D at 6 months; Group 1: mean 0.01 (SD 0.17); n=218, Group 2: mean 0.03 (SD 0.16); n=212
Risk of bias: All domain - Very high, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 17; Group 2 Number missing: 30
- Actual outcome for Moderate-severe: FOSQ - Change score at 6 months; Group 1: mean 6.7 (SD 16.7); n=218, Group 2: mean 6.5 (SD 18.1); n=212
Risk of bias: All domain - Very high, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 17; Group 2 Number missing: 30
- Actual outcome for Moderate-severe: SF36 Physical - change score at 6 months; Group 1: mean 1.2 (SD 9.2); n=218, Group 2: mean 2.6 (SD 9.1); n=212
Risk of bias: All domain - Very high, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 17; Group 2 Number missing: 30
- Actual outcome for Moderate-severe: SF36 mental - change score at 6 months; Group 1: mean 2.5 (SD 12.2); n=218, Group 2: mean 1.4 (SD 11.7); n=212
Risk of bias: All domain - Very high, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 17; Group 2 Number missing: 30

Protocol outcome 2: Sleepiness score at >1 month
- Actual outcome for Moderate-severe: Change in sleepiness score ESS at 6 months; Group 1: mean -4.2 (SD 5.4); n=218, Group 2: mean -4.9 (SD 5.3); n=212
Risk of bias: All domain - Very high, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 17; Group 2 Number missing: 30

Protocol outcome 3: AHI/RDI at >1 month
- Actual outcome for Moderate-severe: AHI at 6 months; MD; Comments: mean difference - mean (SD) - 1.4(18.9);
Risk of bias: All domain - High, Selection - High, Blinding - Low, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 17; Group 2 Number missing: 30

Protocol outcome 4: ODI at >1 month
- Actual outcome for Moderate-severe: ODI at 6 months; MD; , Comments: mean difference - mean(SD) - 1.4(15.7);
Risk of bias: All domain - High, Selection - High, Blinding - Low, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 17; Group 2 Number missing: 30

Protocol outcome 5: Patient preference at >1 month
- Actual outcome for Moderate-severe: Healthcare resource use People given CPAP at 6 months; Group 1: 116/218, Group 2: 143/212

Risk of bias: All domain - High, Selection - High, Blinding - Low, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 17; Group 2 Number missing: 30 Protocol outcome 6: Systolic blood pressure for hypertension at >1 month - Actual outcome for Moderate-severe: Change in 24 hr systolic blood pressure at 6 months; Group 1: mean 0.4 (SD 9.9); n=218, Group 2: mean 0.3 (SD 11); n=212 Risk of bias: All domain - High, Selection - High, Blinding - Low, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 17; Group 2 Number missing: 30 Protocol outcome 7: Cardiovascular events at >1 month - Actual outcome for Moderate-severe: Cardiovascular events at 6 months; Group 1: mean 6.4 (SD 30.7); n=218, Group 2: mean 7.3 (SD 32.7); n=212 Risk of bias: All domain - High, Selection - High, Blinding - Low, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 17; Group 2 Number missing: 30	
Protocol outcomes not reported by the study	Mortality at >1 month; HbA1c for diabetes at >1 month

Appendix F:Coupled sensitivity and specificity forest plots and sROC curves

F.1 Coupled sensitivity and specificity forest plots

Figure 3: Home oximetry All OSAHS (AHI ≥ 5)

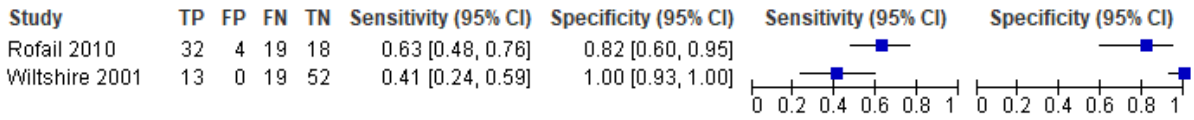


Figure 4: Home oximetry Moderate-severe OSAHS (AHI ≥ 15)

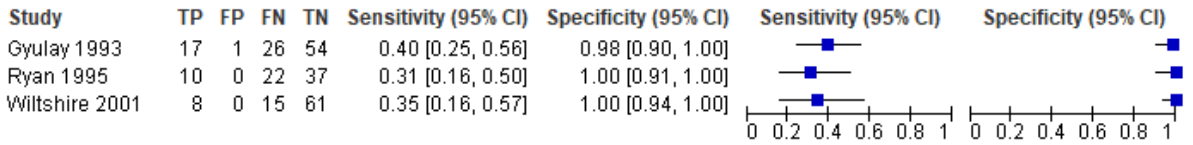


Figure 5: Home respiratory polygraphy all OSAHS (AHI ≥ 5)

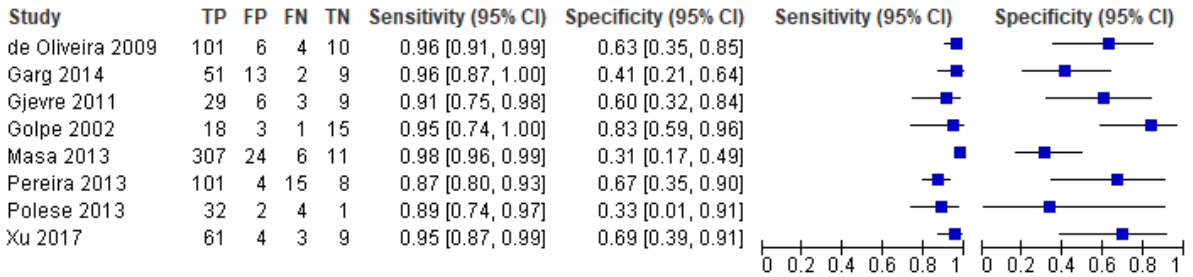


Figure 6: Home respiratory polygraphy moderate-severe OSAHS (AHI ≥ 15)

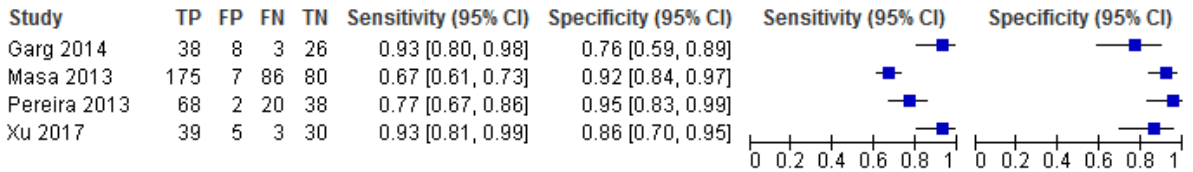


Figure 7: Home respiratory polygraphy severe OSAHS (AHI ≥ 30)

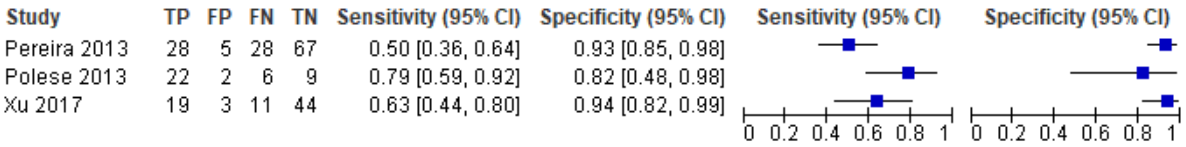


Figure 8: Centre respiratory polygraphy all OSAHS

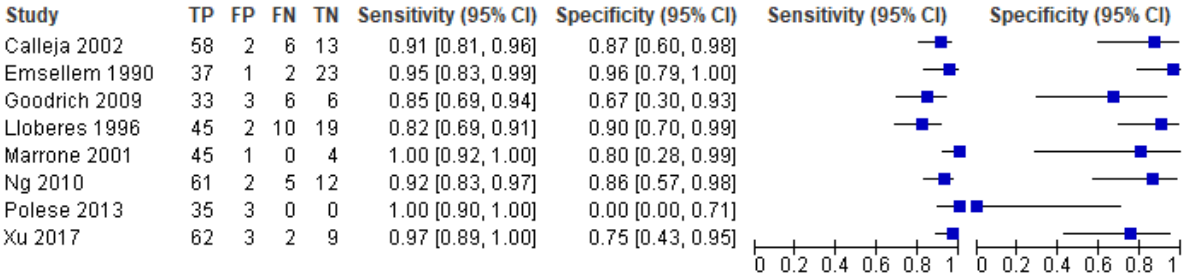


Figure 9: Centre respiratory polygraphy moderate-severe OSAHS

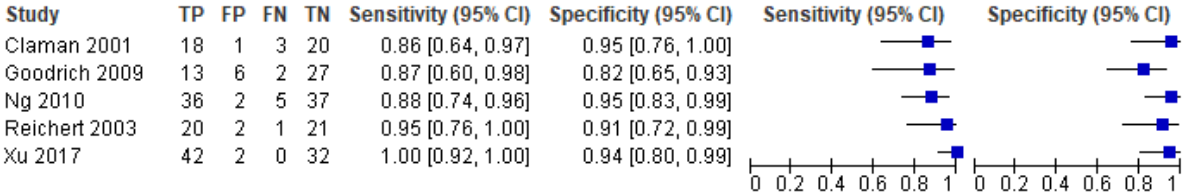
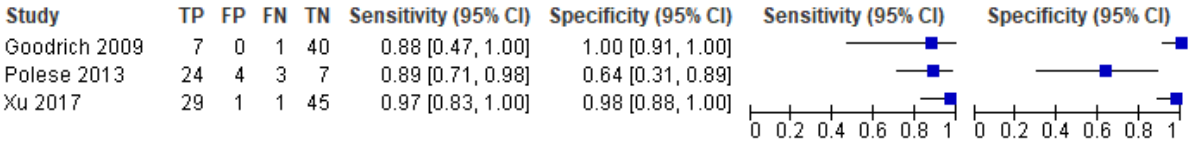


Figure 10: Centre respiratory polygraphy severe OSAHS



F.2 Centre respiratory polygraphy COPD-OSAHS overlap syndrome

Figure 11: Centre respiratory polygraphy all COPD-OSAHS overlap syndrome

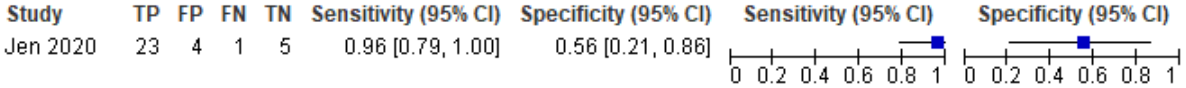


Figure 12: Centre respiratory polygraphy moderate-severe COPD-OSAHS overlap syndrome

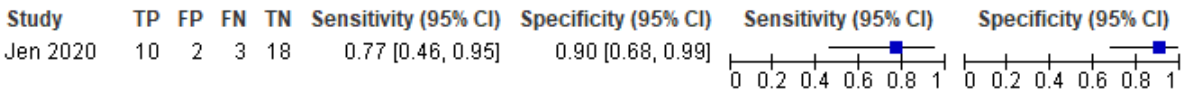
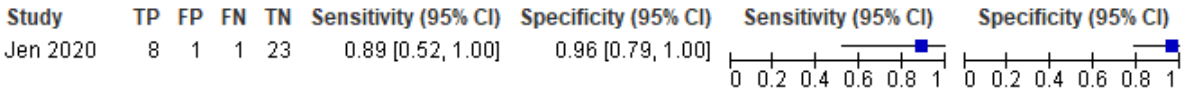


Figure 13: Centre respiratory polygraphy severe COPD-OSAHS overlap syndrome



F.3 Home RP vs Hospital PSG – Test and treat –moderate OSAHS

Figure 14: Change in EQ5D, 0.59-1 (higher is better)

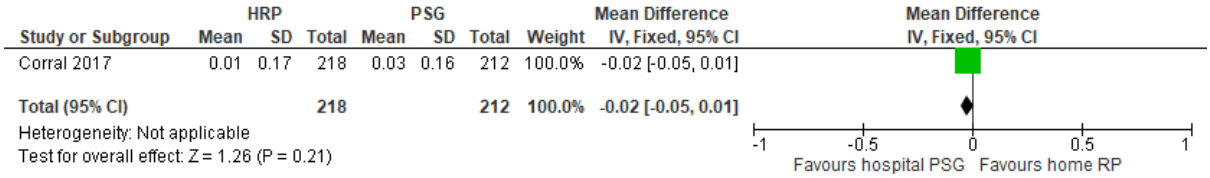


Figure 15: Change in FOSQ, 5-20 (higher is better)

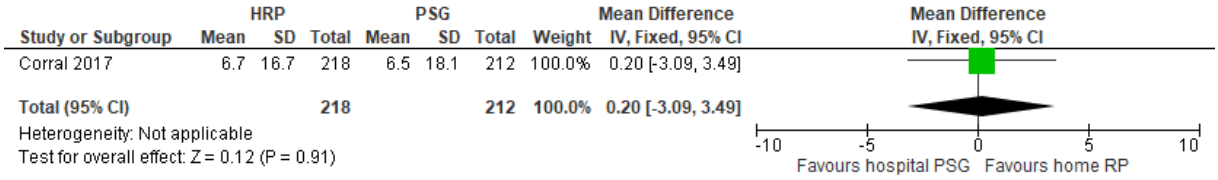


Figure 16: Change in SF36 physical component, 0-100 (higher is better)

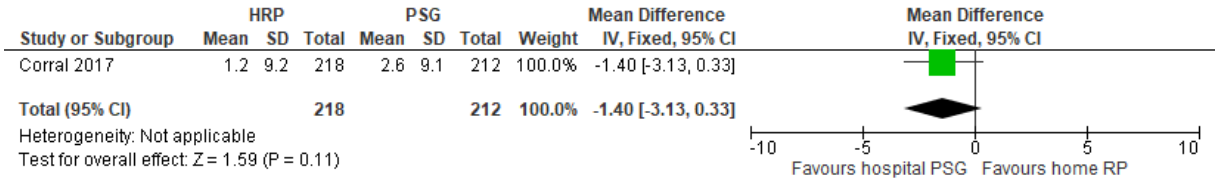


Figure 17: Change in SF36 mental component, 0-100 (higher is better)

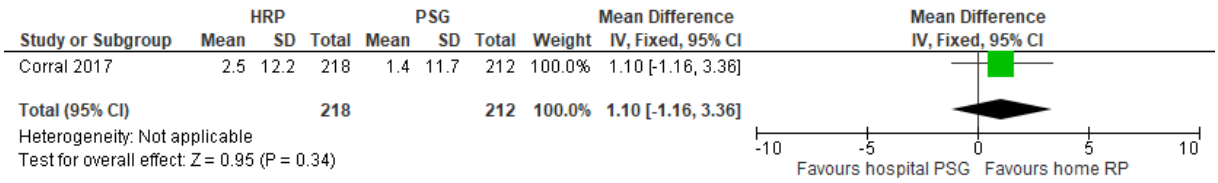
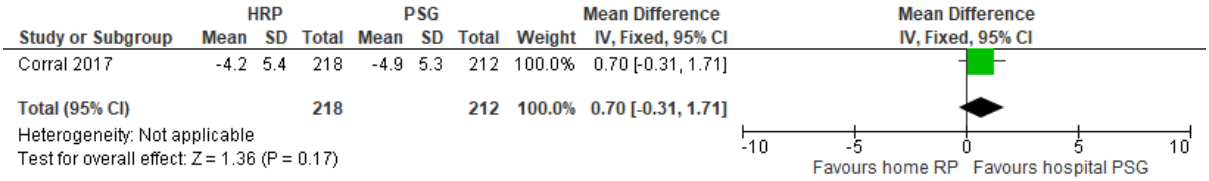
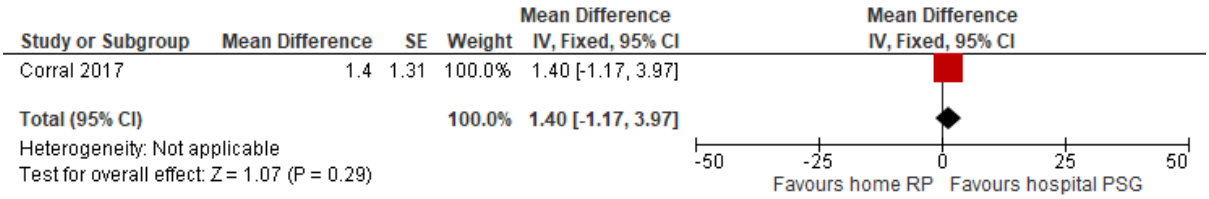


Figure 18: Change in ESS, 0-24 (lower is better)



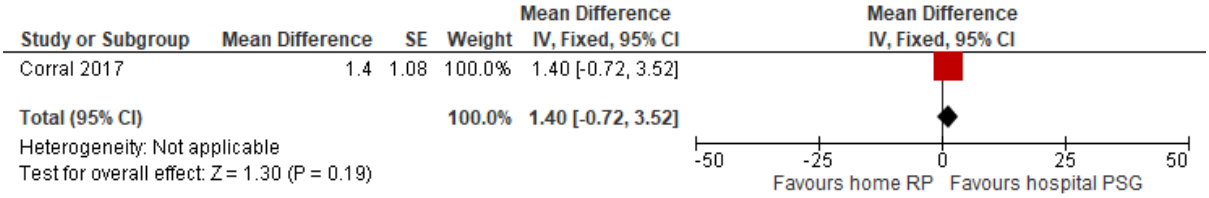
1

Figure 19: AHI, lower is better



2

Figure 20: ODI, lower is better

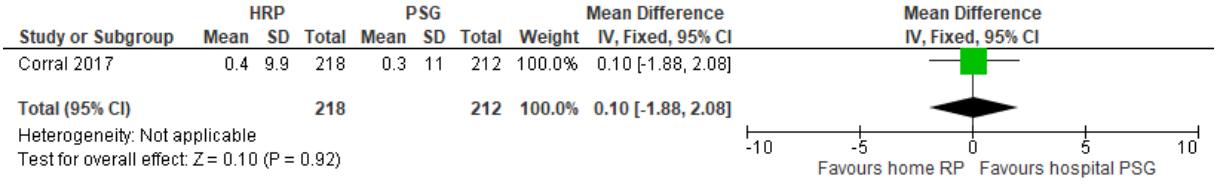


3

Figure 21: People given CPAP, lower is better

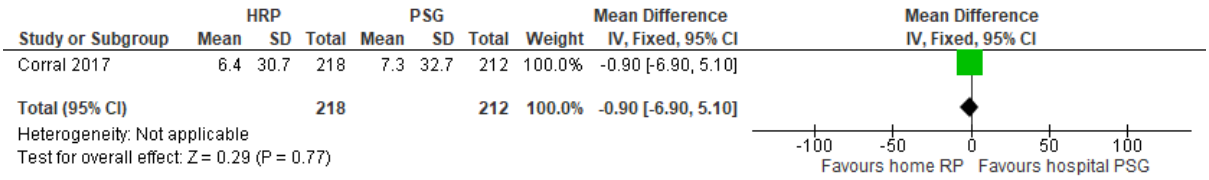
4

Figure 22: Change in 24hr systolic BP, Higher is worse



5

Figure 23: CV event rate, lower is better



sROC curves

Figure 24: Home oximetry All OSAHS (AHI ≥ 5)

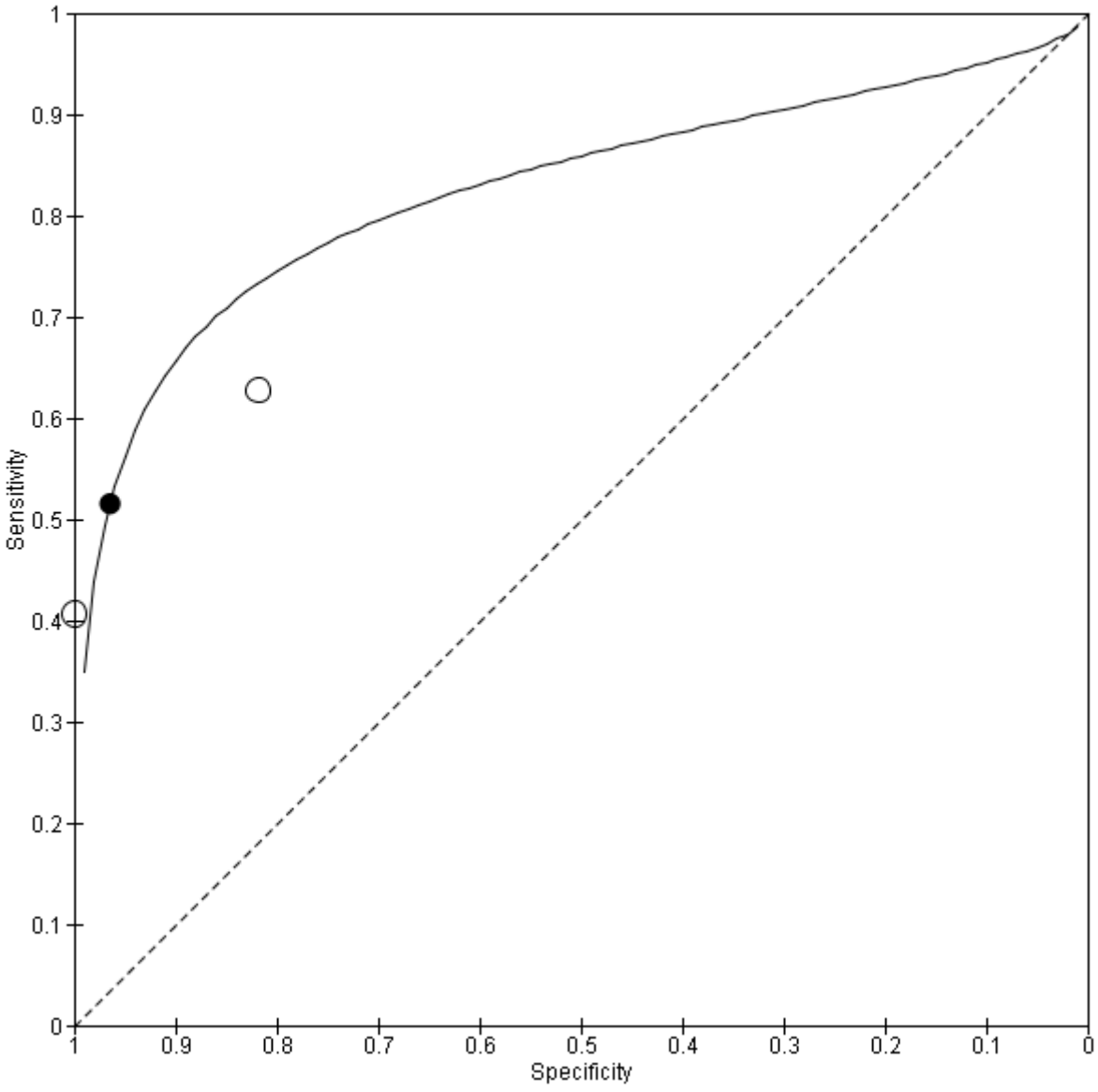


Figure 25: Home oximetry moderate-severe OSAHS (AHI ≥ 15)

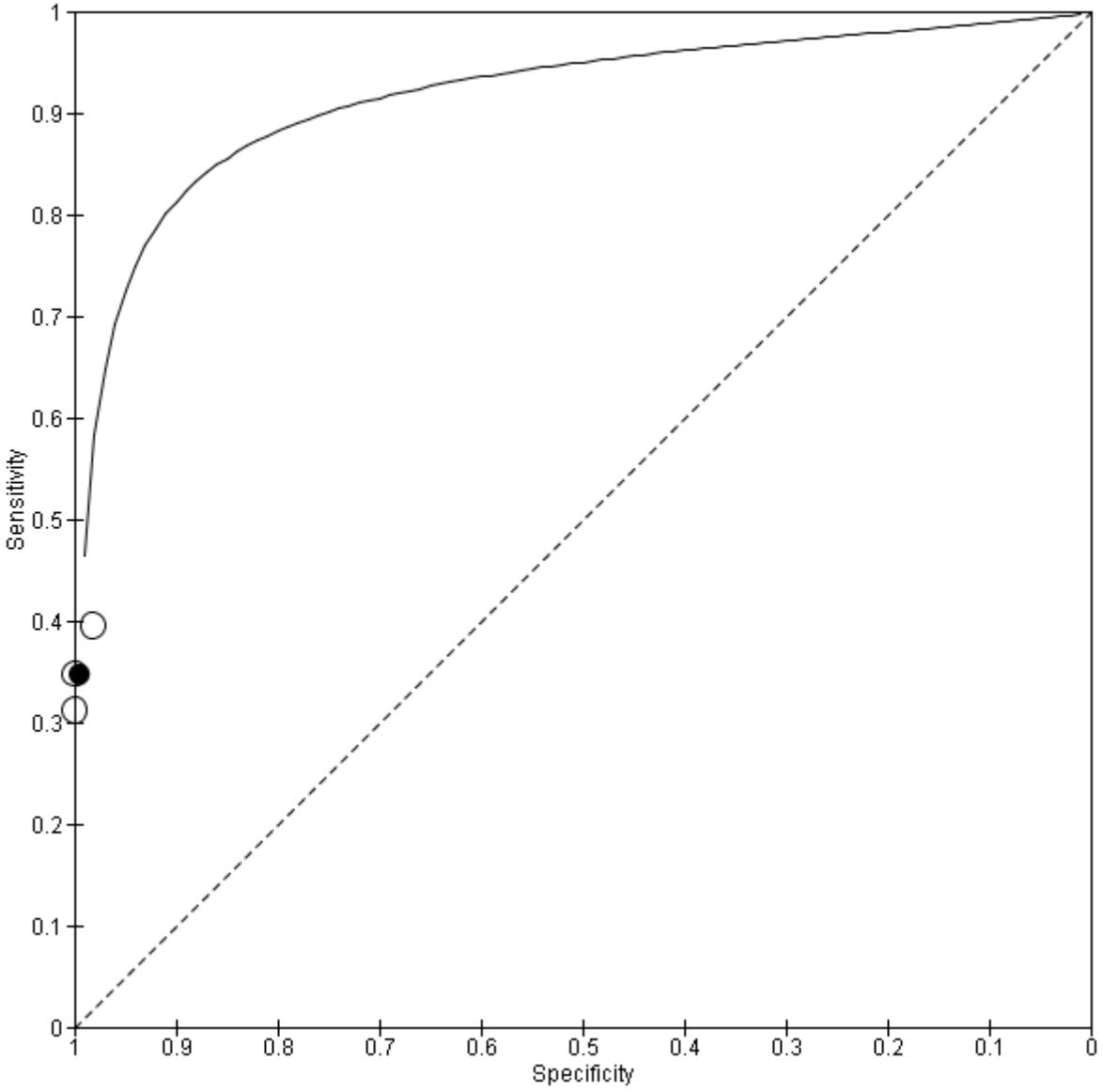


Figure 26: Home respiratory polygraphy all OSAHS (AHI ≥ 5)

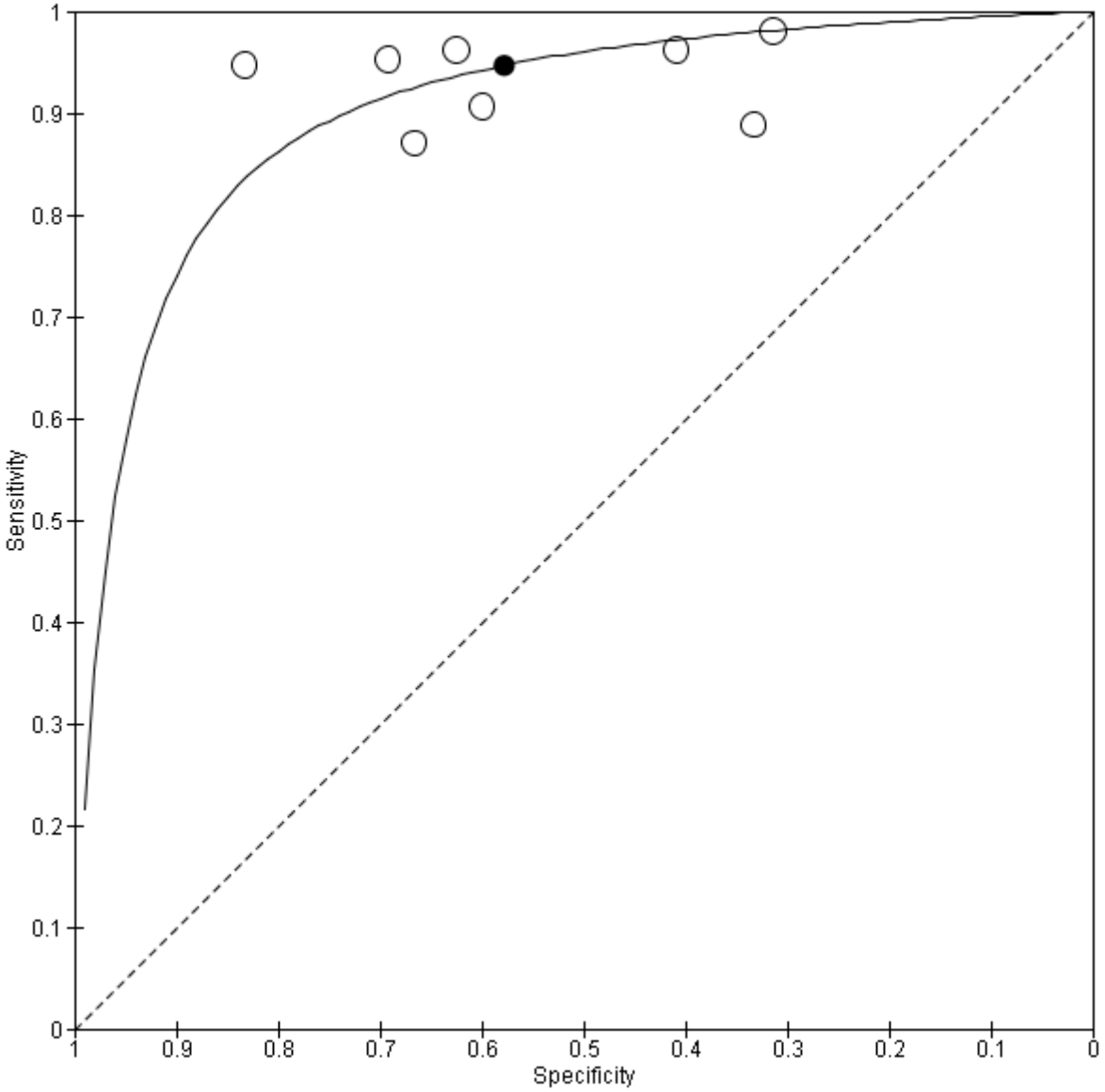


Figure 27: Home respiratory polygraphy moderate-severe OSAHS (AHI ≥ 15)

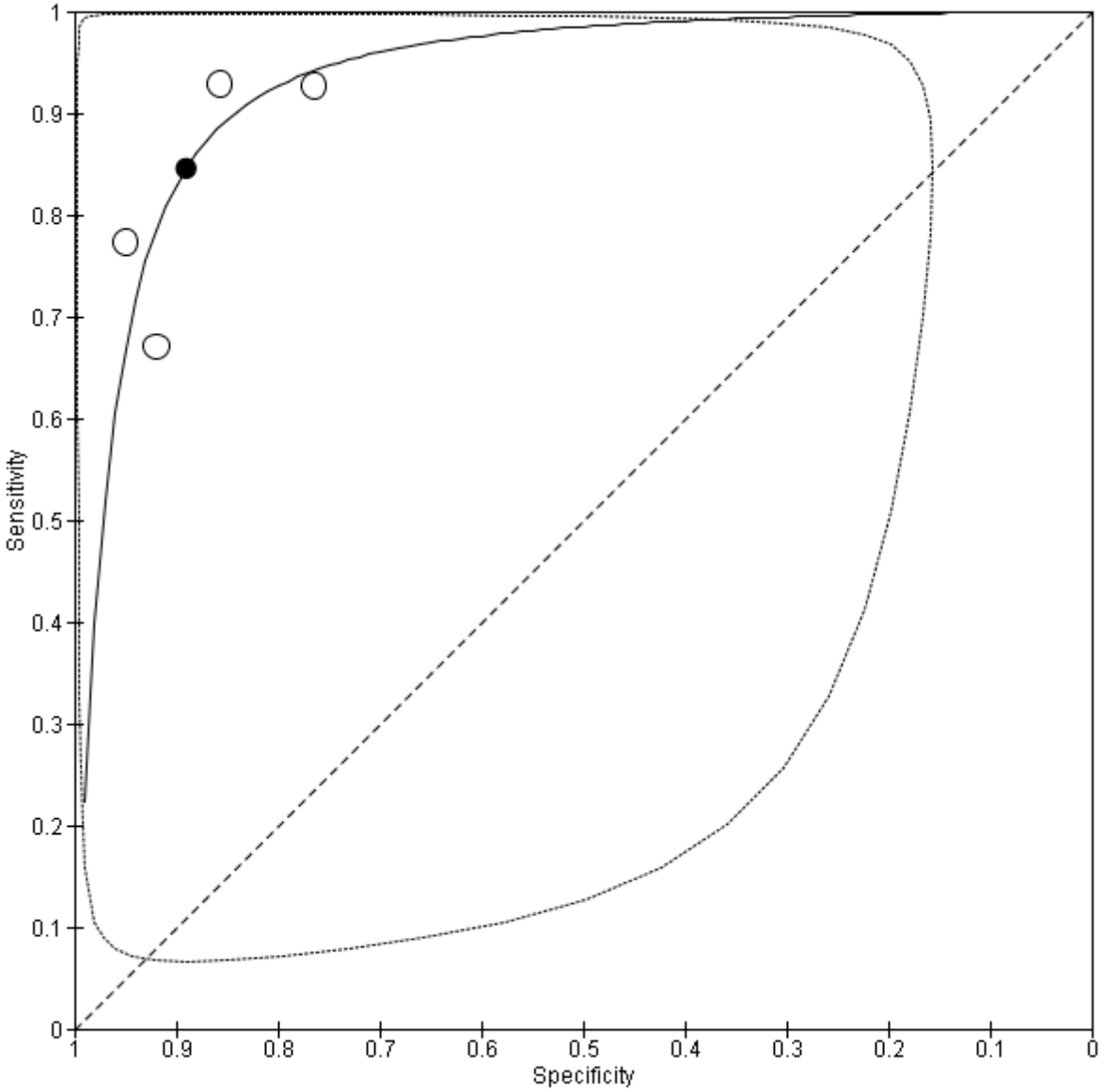


Figure 28: Home respiratory polygraphy severe OSAHS (AHI ≥ 30)

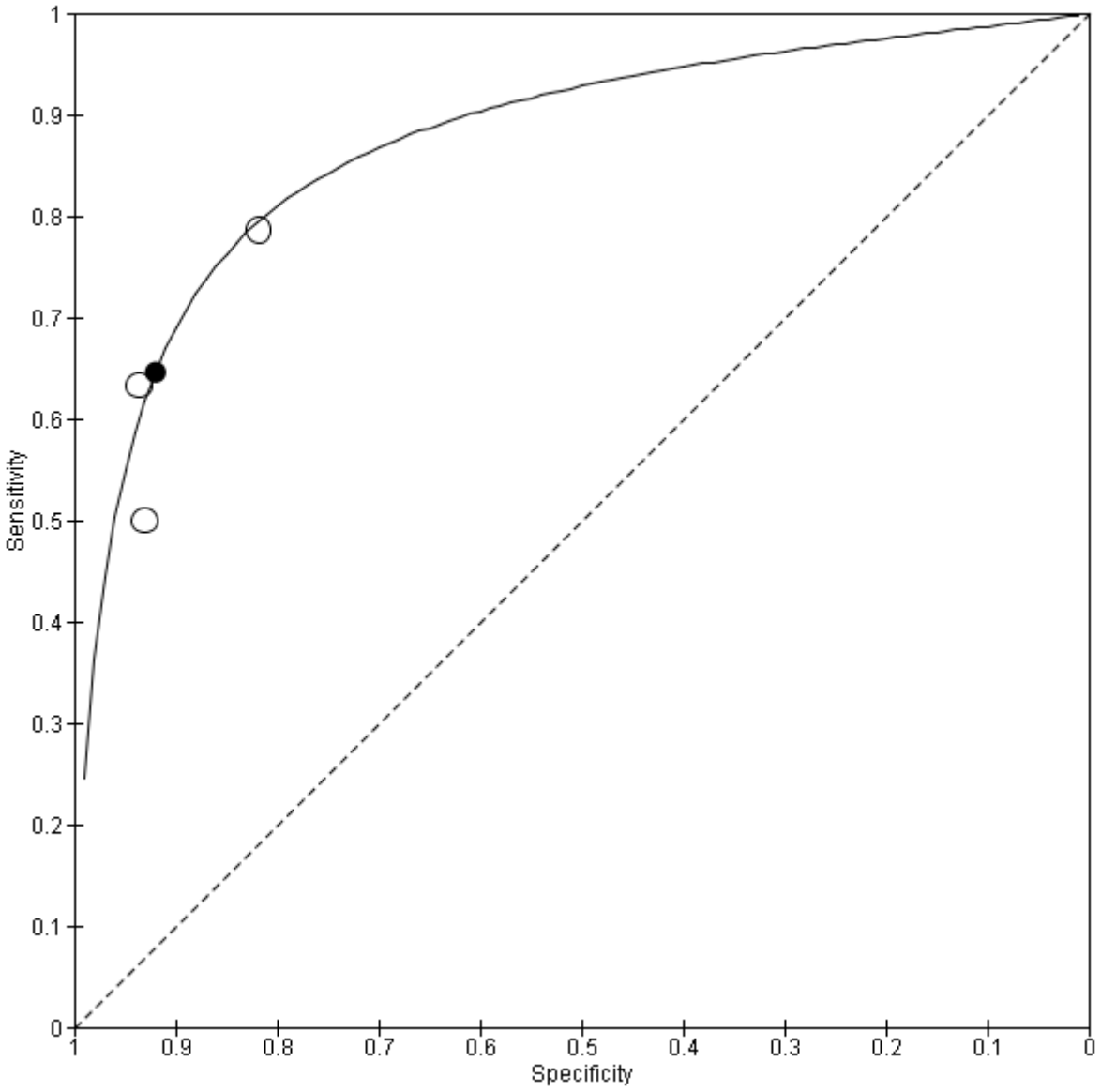


Figure 29: Centre respiratory polygraphy all OSAHS (AHI ≥ 5)

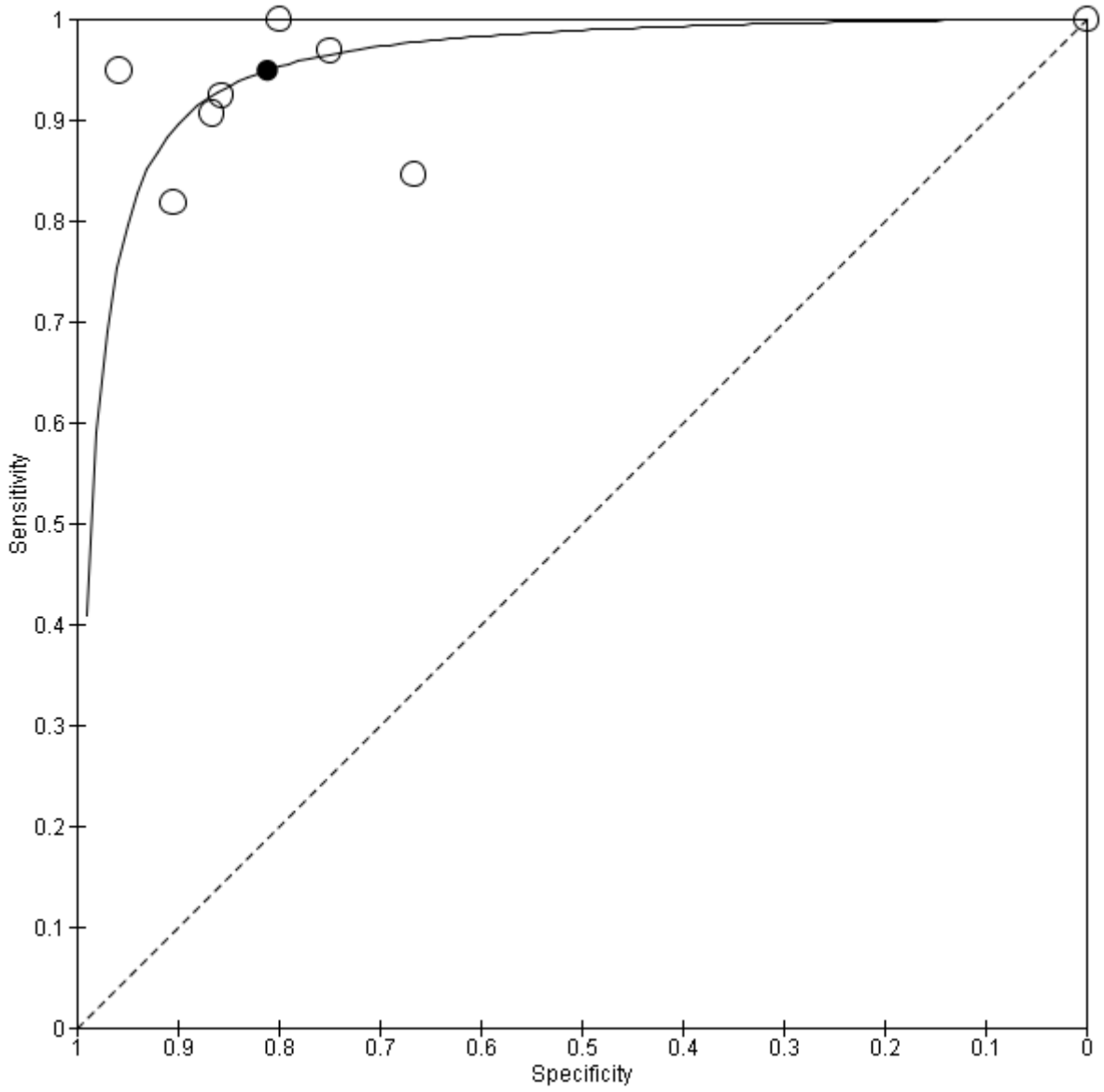


Figure 30: Centre respiratory polygraphy moderate-severe OSAHS (AHI ≥ 15)

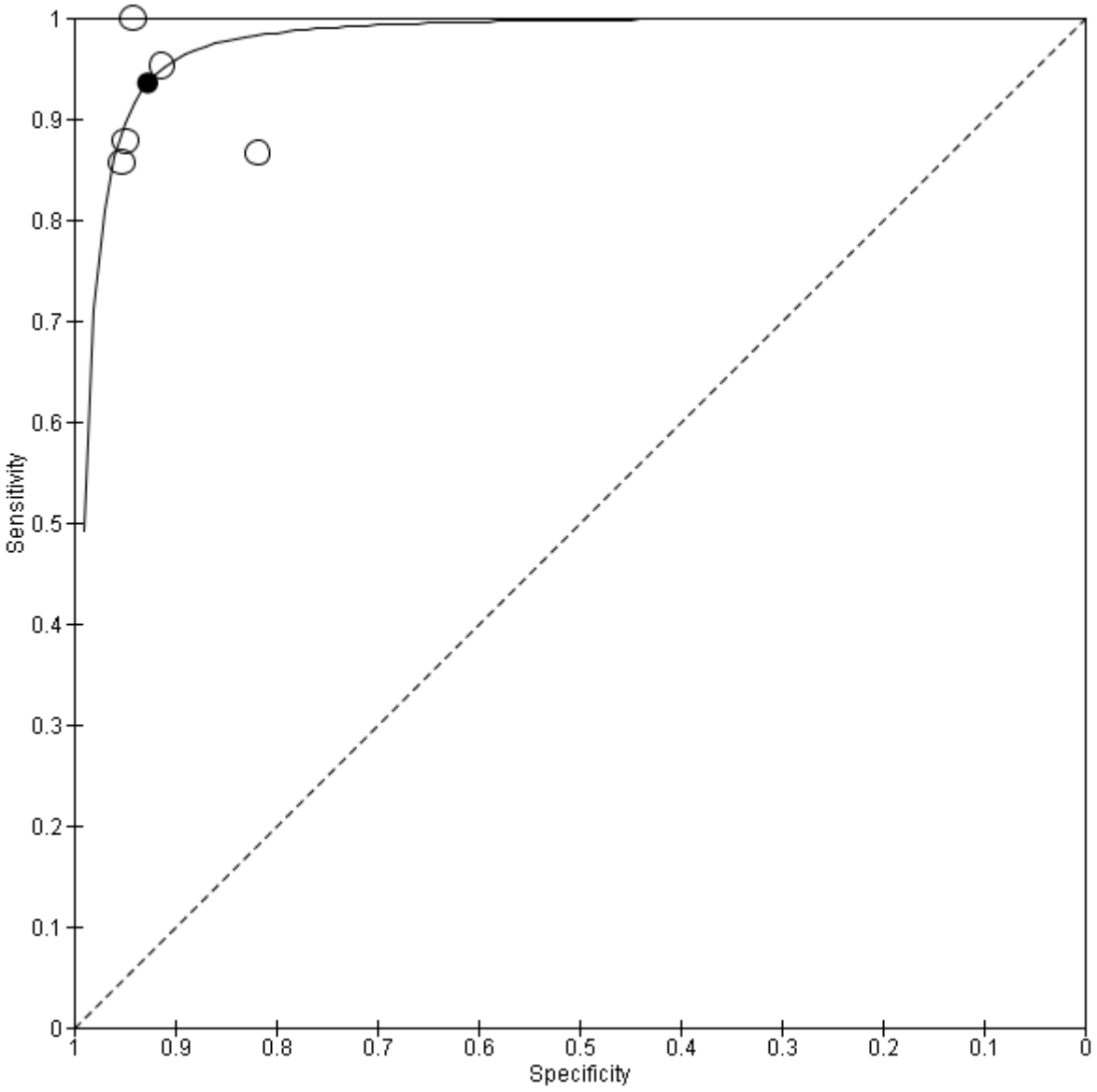


Figure 31: Centre respiratory polygraphy severe OSAHS (AHI ≥ 30)

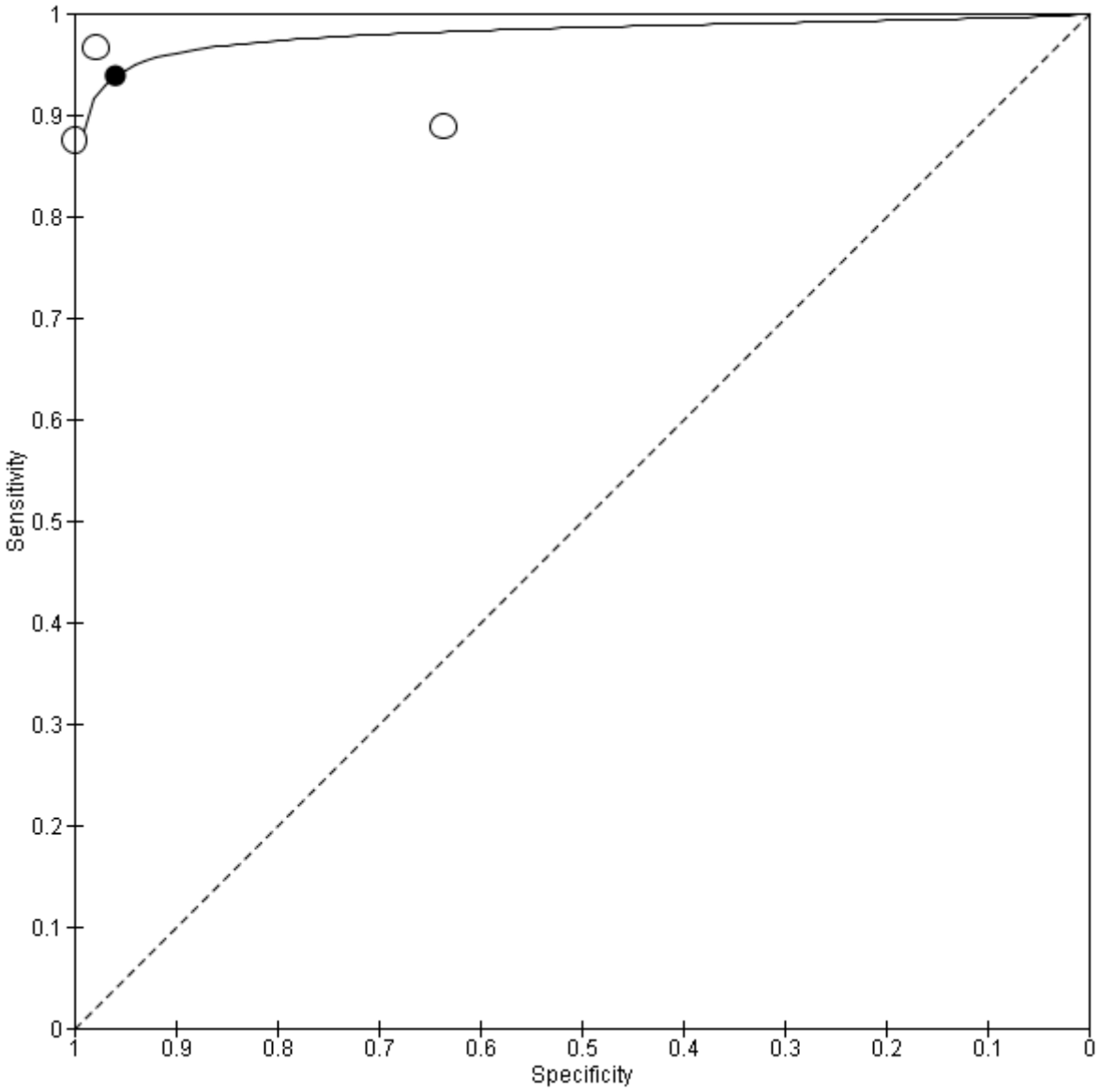


Figure 32: Centre respiratory polygraphy all COPD-OSAHS overlap syndrome (AHI ≥ 5)

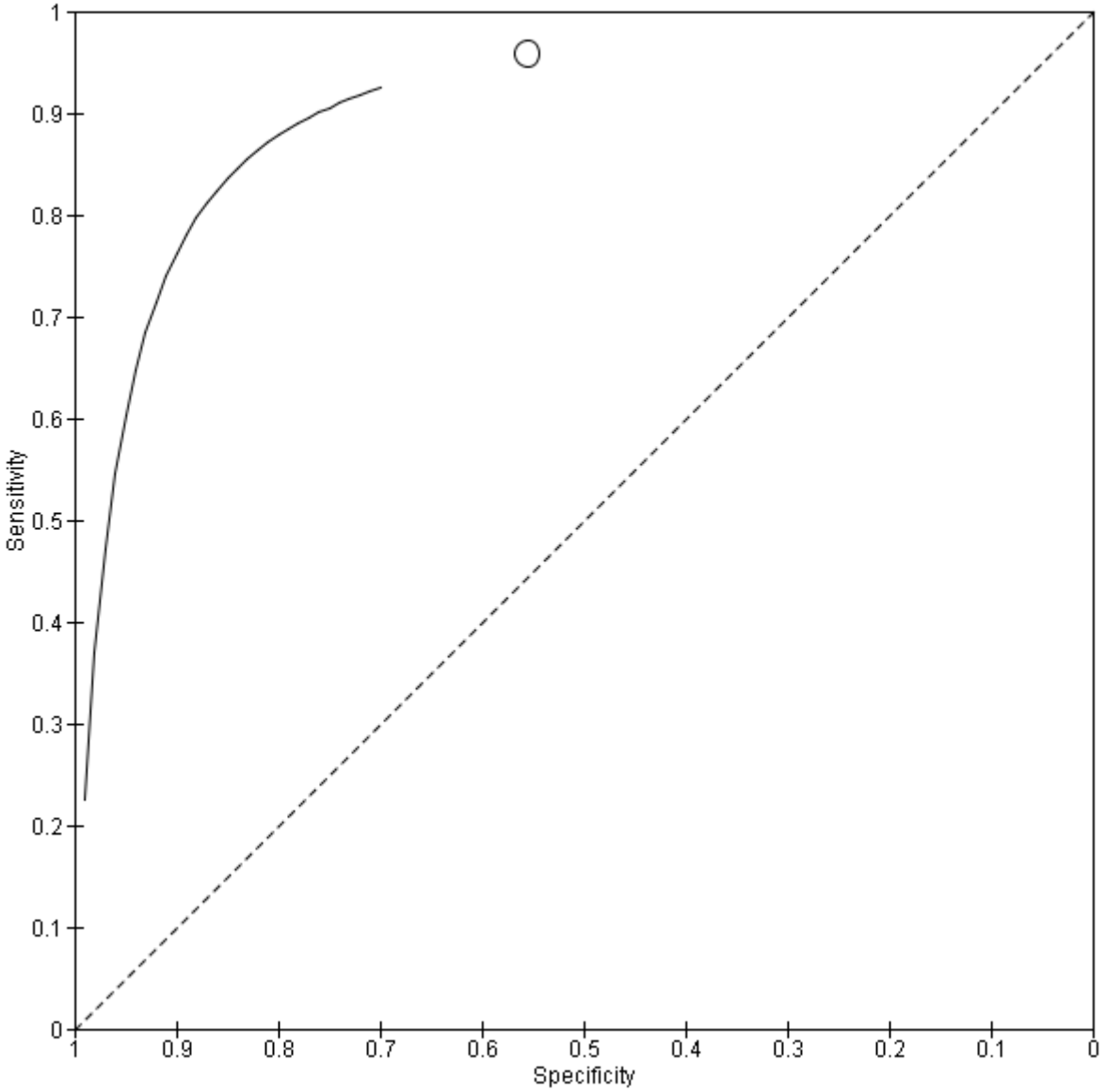


Figure 33: Centre respiratory polygraphy severe OSAHS (AHI ≥ 15)

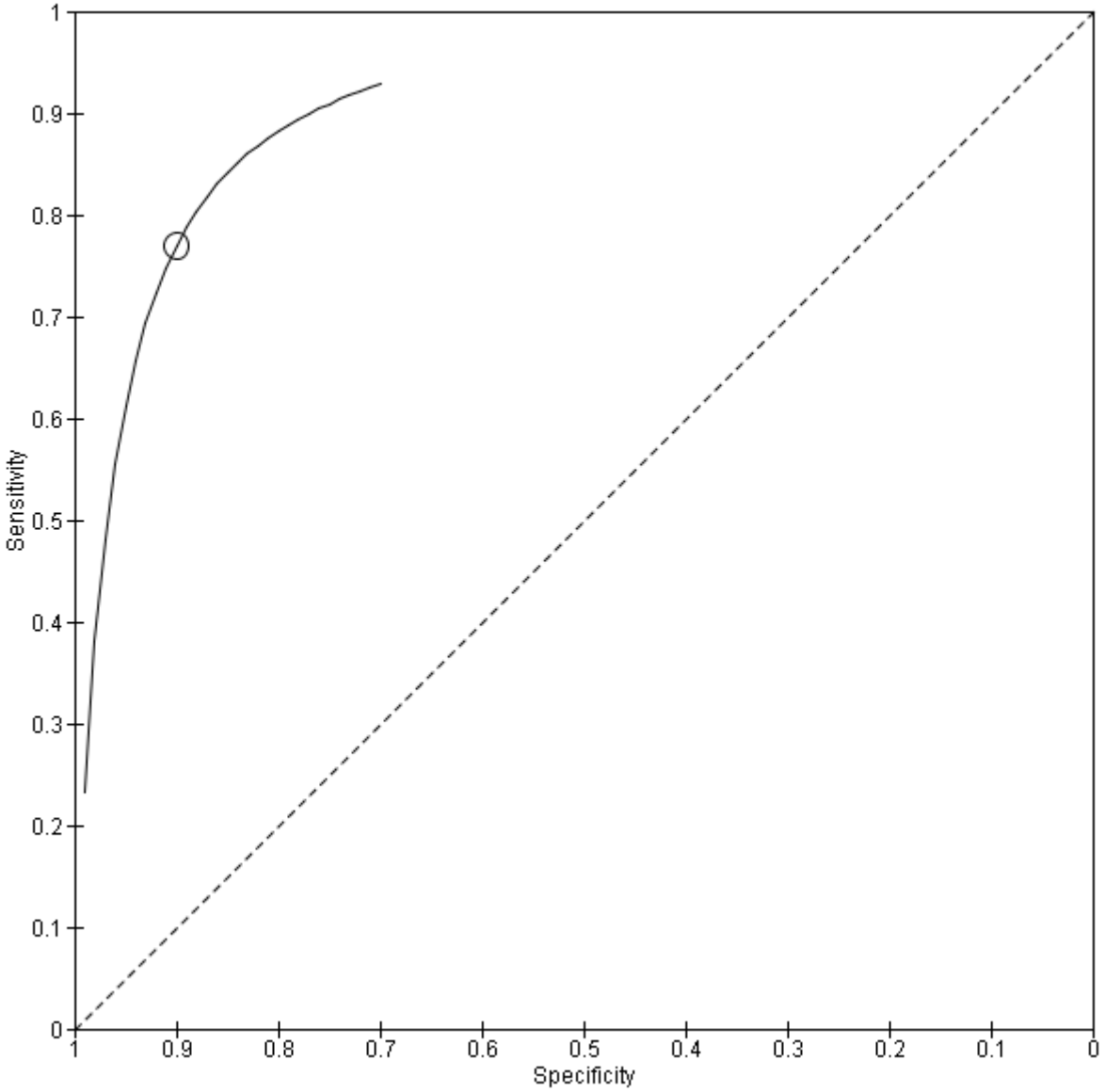
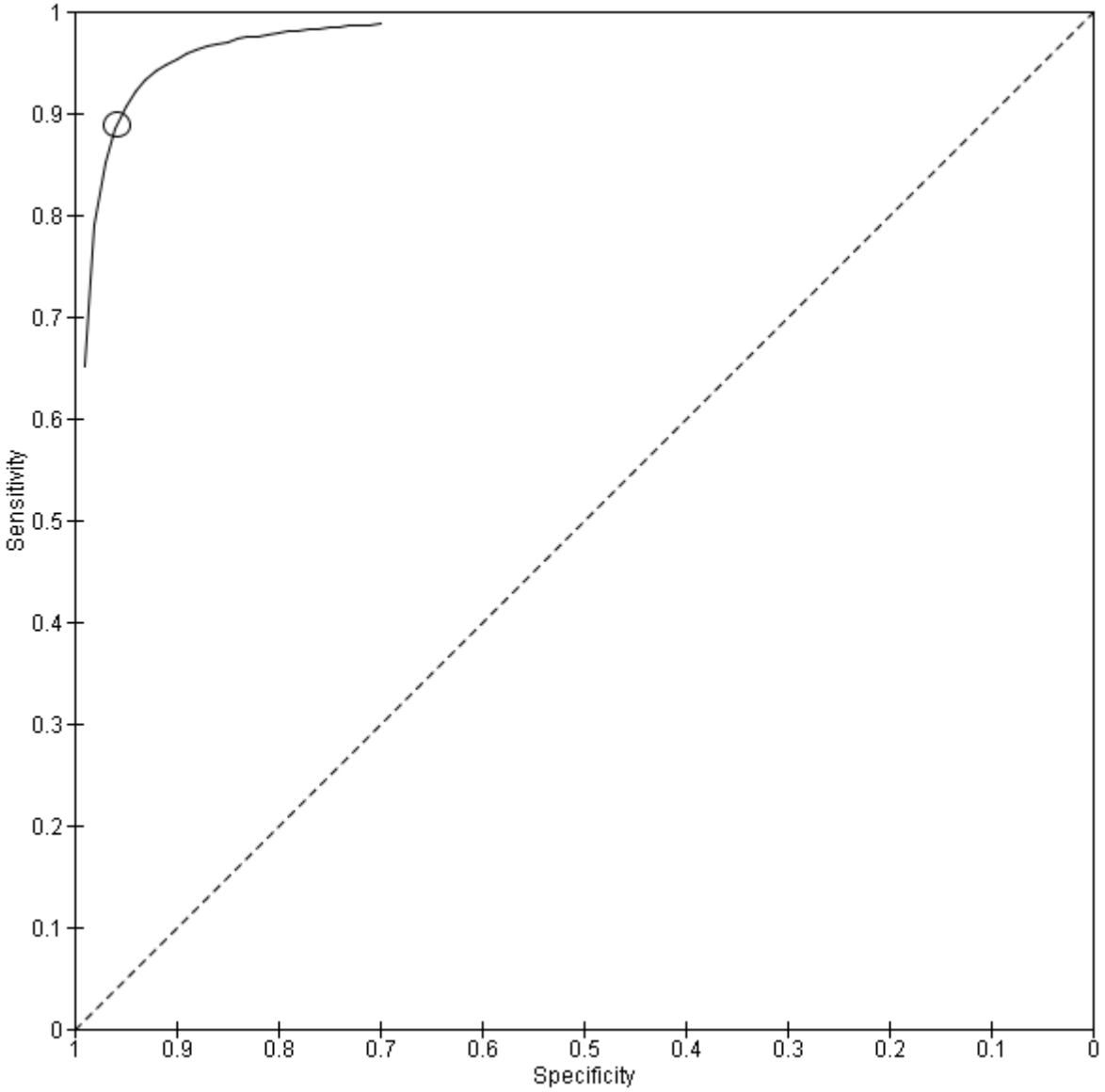


Figure 34: Centre respiratory polygraphy severe OSAHS (AHI ≥ 30)



Appendix G: GRADE tables

Table 25: Clinical evidence profile: Home RP compared to hospital polysomnography- moderate OSAHS (Test and treat study)

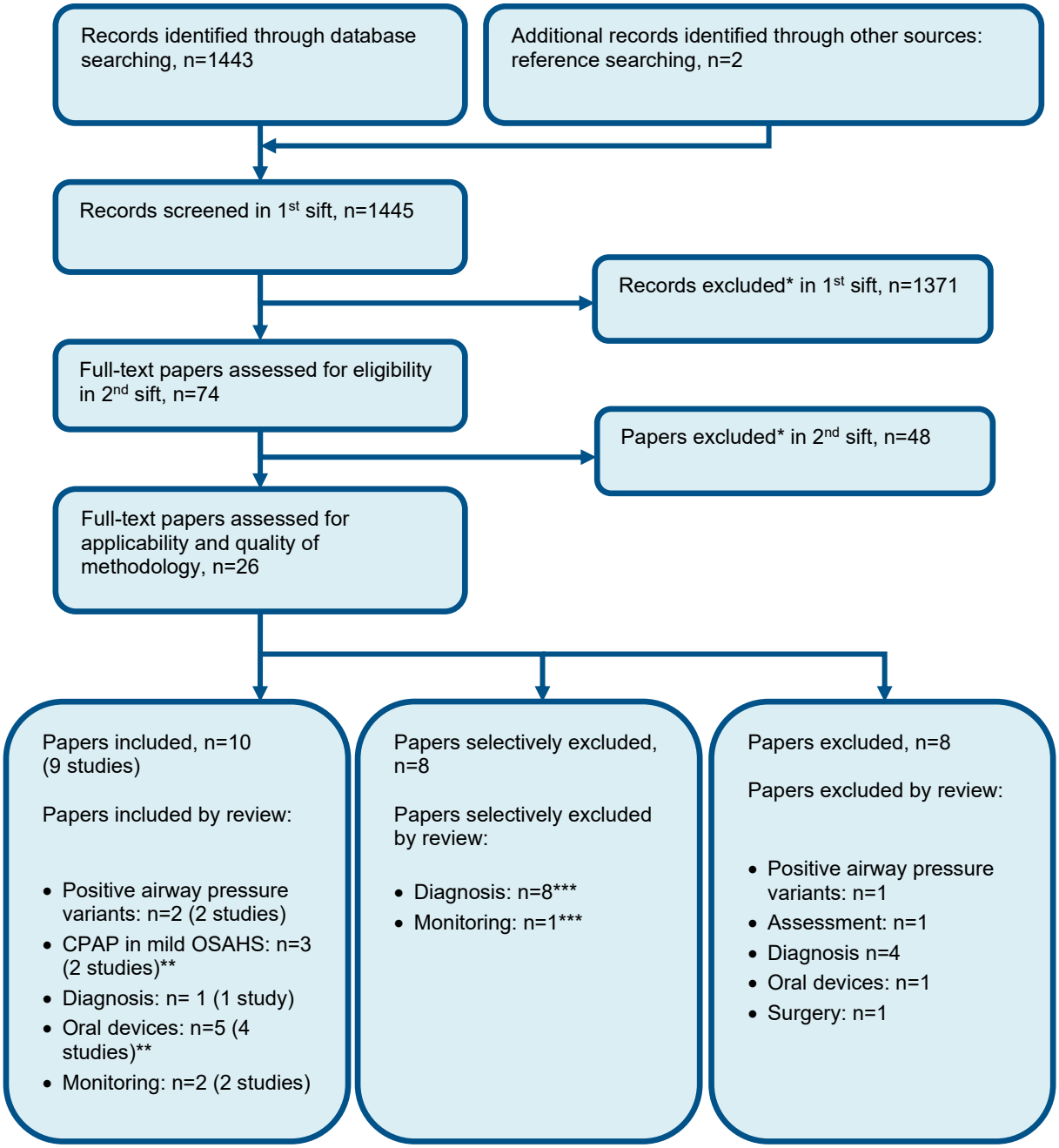
Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Home RP	Hospital PSG	Relative (95% CI)	Absolute		
Change in EQ5D (follow-up 6 months; measured with: EQ5D, higher is better; range of scores: 0-1; Better indicated by higher values)												
1	randomised trials	very serious[1]	no serious inconsistency	no serious indirectness	serious[2]	None	218	212	-	MD 0.02 lower (0.05 lower to 0.01 higher)	⊕OOO VERY LOW	CRITICAL
Change in FOSQ (follow-up mean 6 months; range of scores: 5-20; Better indicated by higher values)												
1	randomised trials	very serious[1]	no serious inconsistency	no serious indirectness	very serious[2]	None	218	212	-	MD 0.2 higher (3.09 lower to 3.49 higher)	⊕OOO VERY LOW	CRITICAL
Change in SF36 Physical (follow-up mean 6 months; Better indicated by higher values)												
1	randomised trials	very serious[1]	no serious inconsistency	no serious indirectness	serious[2]	None	218	212	-	MD 1.4 lower (3.13 lower to 0.33 higher)	⊕OOO VERY LOW	CRITICAL
Change in SF36 mental (follow-up mean 6 months; Better indicated by higher values)												
1	randomised trials	very serious[1]	no serious inconsistency	no serious indirectness	serious[2]	None	218	212	-	MD 1.1 higher (1.16 lower to 3.36 higher)	⊕OOO VERY LOW	CRITICAL
Change in sleepiness score (follow-up 6 months; measured with: ESS, higher is worse; range of scores: 0-24; Better indicated by lower values)												
1	randomised trials	very serious[1]	no serious inconsistency	no serious indirectness	no serious imprecision	None	218	212	-	MD 0.7 higher (0.31 lower to 1.71 higher)	⊕⊕OO LOW	IMPORTANT

AHI (follow-up 6 months; Better indicated by lower values)												
1	randomised trials	serious[1]	no serious inconsistency	no serious indirectness	no serious imprecision	None	218	212	-	MD 1.4 higher (1.17 lower to 3.97 higher)	⊕⊕⊕O MODERATE	IMPORTANT
ODI (follow-up 6 months; Better indicated by lower values)												
1	randomised trials	serious[1]	no serious inconsistency	no serious indirectness	no serious imprecision	None	218	212	-	MD 1.4 higher (0.72 lower to 3.52 higher)	⊕⊕⊕O MODERATE	IMPORTANT
People given CPAP (follow-up 6 months; Better indicated by lower values))												
1	randomised trials	serious[1]	no serious inconsistency	no serious indirectness	serious[2]	None	116/218 (53.2%)	67.9%	RR 0.79 (0.68 to 0.92)	143 fewer per 1000 (from 54 fewer to 217 fewer)	⊕⊕OO LOW	IMPORTANT
Change in 24hr systolic BP (follow-up 6 months; Better indicated by lower values)												
1	randomised trials	serious[1]	no serious inconsistency	no serious indirectness	no serious imprecision	None	218	212	-	MD 0.1 higher (1.88 lower to 2.08 higher)	⊕⊕⊕O MODERATE	IMPORTANT
CV events (follow-up 6 months; measured with: Per 100 patients per year; Better indicated by lower values)												
1	randomised trials	serious[1]	no serious inconsistency	no serious indirectness	no serious imprecision	None	218	212	-	MD 0.9 lower (6.9 lower to 5.1 higher)	⊕⊕⊕O MODERATE	IMPORTANT

[1] Downgraded by 1 increment if the majority of the evidence was at high risk of bias, and downgraded by 2 increments if the majority of the evidence was at very high risk of bias
[2] Downgraded by 1 increment if the confidence interval crossed one MID or by 2 increments if the confidence interval crossed both MIDs. MID for machine usage (adherence)- 1 hour; MID for Systolic and Diastolic BP – 5 mm hg; Established MIDs for SF-36 physical/mental- 2/3; FOSQ- 2 ; ESS -2.5; SAQLI – 2. GRADE default MIDs (0.5XSD) used for all other continuous outcomes.

Appendix H: Health economic evidence selection

Figure 35: Flow chart of health economic study selection for the guideline



* Non-relevant population, intervention, comparison, design or setting; non-English language
** Two studies (in three papers) were included for two different questions
*** One study was considered for two different questions

Appendix I: Health economic evidence tables

Study	Corral 2017[93]			
Study details	**Population & interventions**	**Costs**	**Health outcomes**	**Cost effectiveness**
Economic analysis: Cost-utility analysis **Study design:** Within trial analysis (RCT) **Approach to analysis:** Mean costs and mean QALYs compared over the duration of the study period (6 months). **Perspective:** Spanish provider perspective(a) **Follow-up**: 6 months **Treatment effect duration:** 6 months **Discounting:** Costs = NR Outcomes = NR	**Population:** Patients between the ages of 18-70 referred for pulmonary consultations because of suspected obstructive sleep apnoea (OSA). **Cohort settings:** Median age: 50 N = 430 Drop out: 47 (10.9%) **Intervention 1: (n=201)** <u>Home Respiratory Polygraphy (HRP):</u> (1) Patients were explained by a technician in the hospital how to use the HRP (Embla-Embletta) and then took the device home with them. (2) The patients return the device the next day and the raw data is transmitted to a computer for manual scoring analysis. Those patients that had an invalid HRP test underwent repeat tests with the option to perform a polysomnography test in the hospital if the HRP test continued to be invalid. (3) Therapeutic decision making is conducted (by the same sleep physician) using the Spanish Sleep Network guidelines. CPAP treatment was recommended to patients with a respiratory event index ≥ 5 or an AHI ≥ 5.	**Total costs (mean per patient):** Intervention 1: £292 Intervention 2: £747 Incremental (2−1): £455 (95% CI: NR(b)) **Currency & cost year:** 2014 euros (presented here as 2014 UK pounds (c)) **Cost components incorporated:** HRP and PSG tests (including staff time, equipment, consumable and use of hospital sleep laboratory and repetition of tests when necessary), cost of auto-CPAP titration (including repetition if necessary), cost of CPAP, cost of PSG titration where auto CPAP repetitions were invalid.	**QALYs (mean per patient):** Incremental (2−1): 0.004 (95% CI: 0 to 0.01; p=NR)	**ICER (Intervention 2 versus Intervention 1):** £113,750 per QALY gained **Analysis of uncertainty:** A probabilistic sensitivity analysis (PSA) was conducted which reported that the estimated probability PSG was more expensive than HRP was 100% and that the probability it was more effective was 83%. Probability Intervention 2 cost effective (£20K/30K threshold): 0%/0%(d)

	(4) CPAP patients received auto-CPAP titration; if an optimal pressure was not achieved after three attempts, a polysomnographic titration was provided. **Intervention 2:** Hospital Polysomnography (PSG): (1) Patients received a PSG test and this was repeated where the test was invalid i.e. less than three hours of data was recorded (2) The same as (3) and (4) from intervention 1.			

Data sources
Health outcomes: Health-related quality of life (EQ-5D) reported directly from patients. **Quality-of-life weights:** The EQ-5D tariff used was not stated. **Cost sources:** Resource use from within RCT; costs reported as the mean costs incurred per patient for the trial duration (2012 – 2015) by the 12 Spanish hospitals taking part in the study. HRP and PSG test costs calculated using a linear five-year depreciation of equipment. Cost of using sleep laboratory calculated using the proportional burden of using the laboratory on the general budget of the 12 hospitals.
Comments
Source of funding: Supported by The Spanish society of Pneumology and Thoracic Surgery also known as SEPAR. **Limitations:** The authors have not reported the mean time required to teach patients about using a HRP device neither have they explicitly stated whether this cost has been included in the analysis. The study protocol was unclear on how many invalid HRP tests would necessitate a PSG test. The study was conducted over three years (May 2012 to June 2015) however the costs incurred in each year have not been reported individually. The authors state the PSA's incremental costs were from the year 2015. However, it is unclear whether the PSA includes costs only incurred in the year 2015 or whether the costs from 2012, 2013, 2014 and 2015 have been adjusted so that all costs are now reflecting 2015 costs. There was also a lack of clarity around the health outcomes with the authors reporting a 0.02 incremental change in the EQ-5D but a substantially lower incremental change of 0.004 in QALYs. Despite these limitations, as the incremental cost difference is so large, it is highly unlikely that clarification of these limitations would result in a new ICER which is cost-effective at the £20k threshold.
Overall applicability: Partially Applicable [(e)] **Overall quality:** Minor limitations [(f)]

Abbreviations: AHI = apnoea hypopnoea index; CPAP= continuous positive airway pressure; 95% CI= 95% confidence interval; EQ-5D= Euroqol 5 dimensions (scale: 0.0 [death] to 1.0 [full health], negative values mean worse than death); ICER= incremental cost-effectiveness ratio; NR= not reported; QALYs= quality-adjusted life years

(a) The study also presented patient costs. All costs and ICERs were recalculated by the National Guideline Centre to report a provider perspective, in keeping with the NICE reference case.

(b) Confidence intervals can no longer be reported as the costs had to be recalculated so that only the provider perspective is reported.

(c) Converted using [2014] purchasing power parities[404]

(d) The ICER (x-axis) on the paper's cost-effectiveness acceptability curve included patient costs. However removing these costs would still result in 0%/0% probability that intervention 2 is cost-effective at £20k/£30k thresholds.

(e) Directly applicable / Partially applicable / Not applicable

(f) *Minor limitations / Potentially serious limitations / Very serious limitations*

Appendix J: Excluded studies

J.1 Excluded clinical studies

Table 26: Studies excluded from the clinical review

Reference	Exclusion Reason
Aaronson 2012[2]	Inappropriate index test – hospital oximetry, ODI recorded using polygraph Inappropriate population -stroke patients
Aaronson 2014[1]	Inappropriate index test - SAS questionnaire Inappropriate reference standard - hospital oximetry
Abad 2016[3]	Inappropriate index test – SleepWise nonintrusive video system
Abdelghani 2004[4]	Inappropriate reference standard – PSG at home or in hospital
Abdeyrim 2015[7]	No usable outcomes – no diagnostic accuracy data
Abdeyrim 2016[5]	Inappropriate study design – case control study/ no diagnostic accuracy study
Abdeyrim 2016[6]	Inappropriate index test - impulse oscillometry
Abdullah 2018[8]	Inappropriate index test - The Bahasa Malaysia version of the STOP-BANG questionnaire
Abeyratne 2005[10]	Inappropriate study design - novel feature termed the 'intra-snore-pitch-jump' (ISPJ) to diagnose OSA.
Abeyratne 2013[9]	Inappropriate index test - snore based multi-feature class OSA screening tool
Abraham 2006[11]	Inappropriate population - class III systolic heart failure patients with suspected sleep disordered breathing Inappropriate index test - cardiorespiratory testing system (ClearPath).
Abrahamyan 2018[12]	Systematic review - references checked
Abrishami 2010[13]	Systematic review - references checked
Abumuamar 2018[14]	Inappropriate index test – Stop-Bang questionnaire Inappropriate population- patients with atrial fibrillation
Acharya 2011[15]	Inappropriate index test – electrocardiogram signals
Adachi 2003[16]	Inappropriate index test – pulse rate rise

Reference	Exclusion Reason
Adams 2016[17]	Inappropriate reference standard – home unattended polysomnography
Ahmadi 2008[18]	Inappropriate index test Berlin questionnaire
Akhter 2018[19]	Inappropriate index test – snoring sound
Alakuijala 2016[20]	Inappropriate index test – snoring sound
Alchakaki 2016[21]	Inappropriate index test – snoring sound
Alhouqani 2015[22]	Inappropriate index test – Arabic version of stop bang questionnaire
Almazaydeh 2012[23]	Inappropriate index test – ECG data
Alshaer 2013[25]	Inappropriate index test – acoustic analysis of breathing sounds
Alshaer 2016[26]	Inappropriate index test - cordless acoustic portable device (BresoDx™)
Alvarez 2006[29]	Inappropriate index test – hospital oximetry
Alvarez 2006[32]	Inappropriate index test - nocturnal oximetry using Cross Approximate Entropy (Cross-ApEn).
Alvarez 2007[31]	Inappropriate index test – hospital oximetry
Alvarez 2009[30]	Inappropriate index test – hospital oximetry
Alvarez 2010[28]	Inappropriate index test – oxygen desaturation derived from PSG
Alvarez 2020[27]	Inappropriate reference standard - home polysomnography
Amra 2013[34]	Inappropriate index test - pulmonary function tests Inappropriate population – patients with sleep disordered breathing
Amra 2018[35]	Systematic review - references checked
Amra 2018[33]	Inappropriate index test - questionnaires
Andres-Blanco 2017[36]	Inappropriate index test – laboratory oximetry
Andreu 2012[37]	Inappropriate study design – RCT patients with negative tests were also followed up
Araujo 2018[38]	Inappropriate index test – Apnea link Tm single channel device
Arrazola-Cortes 2017[39]	Inappropriate study design – all patients underwent polysomnography only
Arunsurat 2016[40]	Inappropriate study design – not a diagnostic accuracy study, patients got Berlin questionnaire, no reference standard
Assefa 2016[41]	Inappropriate index test – ApneaStrip device
Aurora 2018[42]	Inappropriate population – Patients with heart failure scored for obstructive

Reference	Exclusion Reason
	and central disordered breathing (ApneaLink Plus) Inappropriate index test - The nasal pressure transducers for polysomnography and respiratory polygraphy units were connected to one nasal cannula through a three-way valve for contemporaneous nasal airflow measurement. The two recording systems were synchronized such that the both tests had equivalent total recording time
Avincsal 2017[43]	Inappropriate index test – modified Stop Bang questionnaire, using modified modified Mallampi score
Ayappa 2008[44]	Inappropriate population – patients with suspected sleep disordered breathing Inappropriate index test The ARES™ consists of the Unicorder device, a self-administered questionnaire, and off-line analysis software.
Ayas 2003[45]	Inappropriate population – patients without suspected OSA
Babaeizadeh 2011[46]	Inappropriate index test-– electrocardiogram derived respiration.Inappropriate population - sleep disordered breathing
Bagnato 2000[47]	Inappropriate index test – AutoSettm (AS) system
BaHammam 2015[48]	Inappropriate index test – Arabic version of Stop Bang questionnaire
BaHammam 2011[49]	Inappropriate index test - ApneaLink™ (AL) is a single-channel type-4 device
Ballester 2000[50]	Inappropriate population – general population
Baltzan 2000[51]	Inappropriate test not oximetry alone - OxiFlow (OF) device which combines oximetry with recording of thermistor airflow.
Banhiran 2014[52]	Inappropriate index test – home polysomnography
Banhiran 2014[53]	Inappropriate index test – Stop-Bang questionnaire
Barak-Shinar 2013[54]	Inappropriate population – Sleep disordered breathing
Barreiro 2003[55]	Inappropriate comparison – polysomnography automatic reading

Reference	Exclusion Reason
	was compared to polysomnography manual reading
Bausmer 2010[56]	No relevant outcomes – no diagnostic accuracy data
Bauters 2020[57]	Inappropriate reference standard – home polygraphy
Beattie 2013[58]	Inappropriate index test – LC system consists of pressure sensors (i.e. LCs) that are placed under the supports of a bed. The LCs detect movement on the bed as fluctuations in the forces supported by each of the bed legs.
Behar 2015[59]	Inappropriate index test – Machine learning, screening application for smartphones was analysed
Behar 2020[60]	Inappropriate index test OxyDOSA, a published machine learning model, was trained to distinguish between non-OSA and OSA individuals using the ODI computed while including versus excluding overnight desaturations overlapping with a wake period, thus mimicking portable and PSG oximetry analyses, respectively
Ben-Israel 2012[61]	Inappropriate index test - Snore sounds were recorded using a directional condenser microphone placed 1 m above the bed.
Berry 2008[62]	Inappropriate index test – RCT patients randomised to PM-APAP and polysomnography, no diagnostic accuracy data
Best 2013[63]	Inappropriate index test - Berlin questionnaire Inappropriate population – patients with treatment resistant depression
Bille 2015[64]	Inappropriate reference standard - cardiorespiratory monitoring
Bingol 2016[65]	Inappropriate index test – Stop – Bang questionnaire was used to predict OHS syndrome, polysomnography was used as a reference standard
Bohning 2011[66]	Inappropriate index test – hospital oximetry
Borsini 2015[68]	Inappropriate reference standard – respiratory polygraphy
Borsini 2019[67]	Inappropriate reference standard - respiratory polygraphy
Boynton 2013 [69]	Not a diagnostic test – Stop-Bang questionnaire
Bradley 1995[70]	–unclear what population was included

Reference	Exclusion Reason
Braganza 2020[71]	Inappropriate study design - non diagnostic accuracy study, study looked at threshold values for excluding CPAP failure
Bravata 2018[72]	Inappropriate index test - patients were randomised to enhanced intervention, standard intervention and control group.
Brown 2014[73]	Inappropriate population – patients within 45 days of stroke onset, patients with predominantly central sleep apnoea were not excluded. Inappropriate index test – ApneaLink Plus – 3 channels
Bsoul 2011[74]	Inappropriate index test - Real-time sleep apnea monitor using single-lead ECG
Cai 2013[75]	Inappropriate index test – Chinese version of ESS questionnaire
Carter 2004[77]	Inappropriate index test – LifeShirt (LS, VivoMetrics, Inc; Ventura CA)
Chai-Coetzer 2017[78]	Inappropriate comparison – RCT, patients randomised full PSG and home RP all participants including those with negative tests were followed up
Chen 2011[79]	Inappropriate index test- - Chinese ESS. Inappropriate population-sleep disordered breathing
Chiner 1999[80]	Inappropriate index test – hospital oximetry
Chiu 2017[81]	Systematic review - references checked
Christensson 2018[82]	Inappropriate reference standard- hospital polygraphy
Chu 2020[83]	Inappropriate index test - patients were randomised to high flux haemodialysis (HF-HD) followed by 2 month haemodiafiltration or vice-versa with 1 month washout via HF-HD
Chung 2007[86]	Inappropriate population – sleep disordered breathing
Chung 2008[89]	Inappropriate population – surgical patients Inappropriate index test - questionnaires
Chung 2012[84]	Inappropriate reference standard – sleep disordered breathing
Chung 2012[85]	Inappropriate index test – questionnaires Inappropriate population – preoperative patients
Chung 2013[88]	Inappropriate index test – questionnaires Inappropriate population – preoperative patients
Chung 2014[87]	Inappropriate index test – questionnaires

Reference	Exclusion Reason
	Inappropriate population – preoperative patients
Clark 2009[91]	Inappropriate reference standard – Embletta polygraphy
Cooper 1991[92]	Inappropriate index test - Biox IIA ear oximeter with the output signal connected to a Rikadenki three channel chart recorder.
Cowan 2014[94]	Inappropriate index test – questionnaires
Crowley 2013[95]	Inappropriate population – sleep disordered breathing
Damiani 2013[98]	Inappropriate index test ESS questionnaire
de Carvalho 2020[99]	Inappropriate study design - Study investigated if WatchPat reduces time to diagnosis and treatment, no diagnostic accuracy study
de Silva 2011[101]	Inappropriate index test – snoring sounds
de Vries 2015[103]	Inappropriate population– patients with heart failure. Inappropriate index test /2 channel sleep screening tool
de Vries 2018[102]	Inappropriate population – bariatric surgery patients Inappropriate study design – optimal cut off values(ODI 1.95) were compared to polysomnography
Deflandre 2017[104]	Inappropriate index test – Stop-Bang questionnaire Inappropriate population – surgical patients
Deflandre 2018[105]	Inappropriate comparison – questionnaires compared with each other
del Campo 2006[106]	Inappropriate index test – hospital oximetry
Dette 2016[108]	Inappropriate population – sleep disordered breathing
Donovan 2020[109]	inappropriate refrence standard - home polygraphy
Doshi 2015[110]	Inappropriate reference standard – portable monitoring
Douglas 1992[111]	Inappropriate index test - polysomnography
Duarte 2017[113]	Inappropriate index test – Portuguese Stop-bang questionnaire
Duarte 2020[112]	Inappropriate reference standard - home polysomnography
Dzieciolowska-Baran 2020 [114]	inappropriate study design- Book chapter. / inappropriate index test - / Data were collected using Brief ICF-Sleep Disorders and Obesity Core Set Polysomnography

Reference	Exclusion Reason
	was performed and basic characteristics of the patients were recorded.
Ebben 2016[115]	Inappropriate index test – hospital oximetry
Ehsan 2020[116]	Inappropriate index test - accuracy of combined home and hospital oximetry in infants was analysed
El Shayeb 2014[117]	Systematic review - references checked
Ellingsen 2020[118]	inappropriate study design - non diagnostic accuracy study, study looked at threshold values for excluding CPAP failure
Epstein 1998[120]	Inappropriate index test - hospital oximetry
Eris Gulbay 2014[121]	Inappropriate study design – not diagnostic accuracy study
Erman 2007[122]	Inappropriate index test- single channel ApneaLink
Ernst 2015[123]	Inappropriate population - snoring, sleep apnea, or diurnal somnolence
Esnaola 1996[124]	No relevant outcomes - selected cut-off points corresponding to the specificity closest to 0.97
Fabius 2019[125]	Inappropriate reference standard - portable monitoring
Faria 2015[126]	Inappropriate index test – Berlin and ESS questionnaires
Farney 1986[127]	Inappropriate index test – hospital oximetry
Fasbender 2019[128]	Inappropriate index test - photoplethysmography
Fawale 2016[129]	No relevant outcomes – no diagnostic accuracy data
Felfeli 2020[130]	Inappropriate index test - patients were randomised to high flux haemodialysis (HF-HD) followed by 2 month haemodiafiltration or vice-versa with 1 month washout via HF-HD
Firat 2012[131]	Inappropriate population - all heavy-vehicle driver's license applicants
Fletcher 2000[132]	Inappropriate reference standard – no polysomnography
Forni Ogna 2015[133]	Inappropriate population – hemodialysis patients
Frangopoulos 2019 [134]	inappropriate reference standard- no polysomnography
Fry 1998[135]	No relevant outcomes – no diagnostic accuracy data
Fuller 2014[136]	Inappropriate comparison – patients randomised to risk assessment only vs risk assessment+ nasal flow group
Gabryelska 2020[137]	inappropriate index test - BOAH scale

Reference	Exclusion Reason
Gagnadoux 2002[138]	Inappropriate index test – home polysomnography
Gantner 2010[139]	Inappropriate reference standard – home polysomnography
Gasa 2013[141]	Inappropriate population- bariatric patients Inappropriate study design – predictive models using anthropometric and clinical predictors were analysed
Geessinck 2018[142]	Inappropriate study design – Markov model
Gergely 2009[143]	Inappropriate index test – sleep strip
Giampa 2018[144]	Inappropriate index test – NoSAS questionnaire
Glantz 2013[146]	Inappropriate population – coronary artery disease patients No relevant outcomes – no diagnostic accuracy data
Glazer 2018[147]	Inappropriate index test - questionnaires Inappropriate population- bariatric patients
Goldstein 2018[148]	Inappropriate index test – HSAT, no diagnostic accuracy data
Golpe 1999[150]	No relevant outcomes – validity indices of oximetry parameters were calculated
Graco 2018[152]	Inappropriate population - chronic tetraplegia Inappropriate index test – tetraplegia specific questionnaire
Gros 2015[153]	Inappropriate population – Parkinson's disease Inappropriate index test – Embletta gold Natus, three channels
Grover 2008[155]	Inappropriate population – sleep disordered breathing
Grover 2018[154]	No relevant outcomes – no diagnostic accuracy data
Gu 2020[156]	Inappropriate index test - Belun ring platform, which captures oxygen saturation, photophlethysmography accelerometers signals
Gugger 1997[157]	Inappropriate index test – Resmed AutoSet
Guimaraes 2012[158]	Not in English
Gumb 2018[159]	Inappropriate population – patients recruited without regard to OSA symptoms
Gunduz 2018[160]	No relevant outcomes – no diagnostic accuracy data
Gupta 2016[161]	Inappropriate index test - Hindi Berlin questionnaire
Ha 2014[163]	Inappropriate index test – Chinese questionnaires

Reference	Exclusion Reason
Hara 2006[165]	Inappropriate index test – voice programme
Hashizaki 2014[166]	Inappropriate index test - contactless biomotion sensor
Heneghan 2008[167]	Inappropriate index test - Electrocardiogram recording
Herer 2002[168]	Inappropriate index test hospital oximetry
Hesselbacher 2012[170]	Not a diagnostic test – ESS questionnaire
Hilmisson 2019[171]	Inappropriate index test - ECG analysis
Holmedahl 2019[172]	Inappropriate index test - patients were randomised to enhanced intervention, standard intervention and control group. Not test and treat study, patients were randomised to beetroot juice containing nitrate or placebo
Hong 2018[173]	Inappropriate population – sleep disordered breathing
Horvath 2018[174]	Inappropriate reference standard – hospital polygraphy Inappropriate population – bariatric surgery patients
Hui 2017[175]	Inappropriate index test - ambulatory approach versus the hospital-based approach
Hussain 2003[176]	Inappropriate study design - patients with normal oximetry results were recruited
Iber 2004[177]	Inappropriate index test – home polysomnography
Ibrahim 2007[178]	No relevant outcomes – nodiagnostic accuracy data
Ioachimescu 2020[179]	Inappropriate study design - non diagnostic accuracy study, study analysed performance of peripheral arterial tonometry
Isaac 2017[180]	Inappropriate population – patients admitted for any medical reason
Jen 2020[181]	Inappropriate study design - no diagnostic accuracy data.wrong population COPD patients not overlap syndrome
Jobin 2007[182]	Systematic review - references checked
Kahal 2020[184]	Inappropriate comparison - respiratory poligraphy manual scoring compared to respiratory polygraphy automatic scoring
Kaminska 2010[185]	Systematic review - references checked
Karakoc 2014[186]	Inappropriate reference standard – no polysomnography
Karaloglu 2017[187]	Inappropriate comparison – polysomnography vs polysomnography

Reference	Exclusion Reason
Katzan 2016[188]	Inappropriate population – cerebrovascular patients (ischemic stroke, intracerebral haemorrhage and carotid occlusion
Khandoker 2009[189]	Inappropriate index test - short-term electrocardiogram recordings
Kicinski 2016[190]	Inappropriate population – sleep disordered breathing
Kiely 1996[191]	Inappropriate index test -ResCare Autoset
Kim 2015[192]	Inappropriate index test – Korean questionnaires
Kim 2015[193]	Inappropriate study design - economic analysis
Korvel-Hanquist 2018[194]	Inappropriate index test – Danish Stop Bang questionnaire
Kristiansen 2020[195]	Inappropriate comparison - manual respiratory polygraphy compared to automatic respiratory polygraphy
Kukwa 2020[196]	Inappropriate study design - study comparing in-laboratory PSG and HSAT using a peripheral arterial tone (PAT) technology device. No diagnostic accuracy data
Kum 2015[198]	Inappropriate index test – Turkish ESS questionnaire
Kum 2018[197]	Inappropriate index test – oximetry from polysomnography
Kuna 2011[199]	Inappropriate index test – analysis under 3 conditions 1. traditional PSG, 2. modified PSG + Lifeshirt, 3. Lifeshirt at home. Lifeshirt – 3 channels
Lachapelle 2019[200]	Inappropriate population – patients with inconclusive home study results were included in the analysis
Lado 2011[201]	Inappropriate index test – assessment of ECG databases
Lajoie 2020[202]	Inappropriate study design - aim of the study was to determine the accuracy of home oximetry to distinguish between nocturnal oximetry desaturation relapsed to COPD alone or to sleep apnoea in patients with moderate to severe COPD who have significant nocturnal hypoxemia with clinical changes in saturation. no relevant outcomes - no sensitivity or specificity data
Lam 2010[203]	Inappropriate population – patients screened from diabetes mellitus database Inappropriate relevant outcomes – no diagnostic accuracy data
Laohasiriwong 2013[204]	No relevant outcomes – no diagnostic accuracy data

Reference	Exclusion Reason
Laporta 2012[205]	Inappropriate population – Ischemic heart disease patients Inappropriate – index test, Berlin questionnaire
Laranjeira 2018[206]	Inappropriate study design – not a diagnostic accuracy study
Lauritzen 2018[207]	Inappropriate index test – Danish Berlin questionnaire
Lazaro 2020[208]	Not in English
Le 2016[209]	Inappropriate study design – not diagnostic accuracy study
Leclerc 2014[210]	No relevant outcomes - No diagnostic accuracy data
Lee 2008[211]	Inappropriate index test – multisensory manometry No relevant outcomes – no diagnostic accuracy data
Lee 2011[215]	Inappropriate population – patients with diagnosed OSA
Lee 2012[219]	Inappropriate population – patients with diagnosed OSA
Lee 2013[214]	Inappropriate study design - snoring detection method based on hidden Markov models
Lee 2015[213]	Inappropriate study design - Nasal pressure recordings for automatic snoring detection
Lee 2015[217]	Inappropriate population – patients with diagnosed OSA
Lee 2015[218]	Inappropriate population – patients with diagnosed OSA
Lee 2016[212]	Inappropriate population – patients with diagnosed OSA
Lee 2016[216]	Inappropriate population – patients with diagnosed OSA
Leitzen 2014[220]	No relevant outcomes – no diagnostic accuracy data
Lentini 2006[221]	Inappropriate index test – serum creatine phosphokinase
Leppanen 2016[222]	Inappropriate study design – study analysed RemLogic™ plug-in
Levartovsky 2016[223]	Inappropriate index test – breathing and snoring sounds recorded by polysomnography
Levendowski 2009[224]	Inappropriate population – untreated OSA patients
Levendowski 2015[226]	Inappropriate index test- neck device measuring loud snoring
Levendowski 2018[225]	No usable outcomes – no diagnostic accuracy data
Levy 1996[227]	Inappropriate index test – hospital oximetry
Li 2014[230]	Inappropriate population – confirmed OSA

Reference	Exclusion Reason
Li 2017[229]	Inappropriate index test - photoplethysmograph
Li 2018[228]	Inappropriate index test - single-lead ECG signal
Liam 1996[231]	Inappropriate index test – Edentrace II
Liang-Wen Hang 2015[164]	Inappropriate index test – hospital oximetry
Liesching 2004[232]	No diagnostic accuracy data. Inappropriate index test -SNAP technology sleep sonography
Lim 2008[234]	No index test – polysomnography data was analysed
Lim 2018[233]	Inappropriate index test – Soft palate length with velum obstruction
Lin 2009[235]	Inappropriate population – patients with diagnosed OSA
Ling 2012[236]	Inappropriate index test – hospital oximetry
Linz 2018[237]	Inappropriate index test - hospital oximetry
Lipatov 2018[238]	Inappropriate population – patients with negative polysomnography
Littner 2005[239]	Inappropriate study design – Literature review
Liu 2012[240]	No relevant outcomes – no diagnostic accuracy data
Liu 2017[241]	Inappropriate index test – support vector machine was used to predict model for severity of OSA
Lloberes 2001[243]	No relevant outcomes – no diagnostic accuracy data
Lopes 2008[244]	Inappropriate study design – not a diagnostic accuracy study
Lopez-Acevedo 2009[246]	Inappropriate study design – not a diagnostic accuracy study
Lopez-Acevedo 2009[245]	Inappropriate study design – not a diagnostic accuracy study
Lu 2017[247]	Inappropriate population – asthma patients
Lucey 2016[248]	Inappropriate index test – single channel EEG
Luo 2014[249]	Inappropriate index test – Chinese questionnaires
Luo 2014[250]	Inappropriate index test – Chinese questionnaires
Luo 2015[251]	Inappropriate index test - nomogram
Macavei 2013[252]	Inappropriate reference standard – partial pressure of carbon dioxide (pCO2)
MacGregor 2013[253]	Inappropriate index test - tracheal breath sounds
MacGregor 2014[254]	Inappropriate study design – conference proceedings
Mador 2005[255]	Inappropriate study design – not a diagnostic accuracy study

Reference	Exclusion Reason
Maeder 2015[256]	Inappropriate study design – not a diagnostic accuracy study
Maestri 2011[257]	Inappropriate study design – not a diagnostic accuracy study
Magalang 2003[258]	Inappropriate index test – hospital oximetry
Magnusdottir 2018[259]	Inappropriate index test - single-lead electrocardiogram signal
Mahakit 2012[260]	Inappropriate index test – daytime polysomnography
Maier 2006[261]	Inappropriate index test - electrocardiogram
Maier 2011[263]	Inappropriate index test - electrocardiogram
Maier 2014[262]	Inappropriate index test - electrocardiogram
Maimon 2010[264]	Inappropriate index test - snoring
Maislin 1995[265]	Inappropriate study design – not diagnostic accuracy study
Makarie Rofail 2008[266]	Inappropriate index test – nasal flow
Malbois 2010[267]	Inappropriate comparison – oximetry compared to polygraphy
Man 1995[268]	Inappropriate population - SDB
Mandal 2014[269]	Inappropriate population – sleep disordered breathing
Manoochehri 2018[270]	Inappropriate index test – models LRM and C5.0
Manoochehri 2018[271]	Inappropriate index test – support vector machine based algorithm
Manser 2001[272]	Inappropriate study design – different scoring methods analysed, not diagnostic accuracy study
Manuel 2015[273]	Inappropriate study design – not a diagnostic accuracy study
Maranate 2015[274]	Inappropriate index test – not a diagnostic accuracy study
Marcos 2007[277]	Inappropriate study design – conference proceedings
Marcos 2008[278]	Inappropriate population – patients with atrial fibrilation
Marcos 2008[281]	Inappropriate index test – not a diagnostic accuracy study
Marcos 2009[280]	not a diagnostic accuracy study
Marcos 2009[279]	not a diagnostic accuracy study
Marcos 2010[276]	not a diagnostic accuracy study
Marcos 2010[282]	not a diagnostic accuracy study
Marcos 2011[283]	not a diagnostic accuracy study
Marcos 2012[275]	not a diagnostic accuracy study
Marcos 2016[284]	not a diagnostic accuracy study
Margallo 2014[285]	Inappropriate population- patients with resistant hypertension

Reference	Exclusion Reason
	Inappropriate index test - questionnaires
Martinez 2005[292]	Inappropriate index test – hospital oximetry
Martinez 2009[291]	Inappropriate study design – not a diagnostic accuracy study
Martinez 2011[289]	Inappropriate population – sleep disordered breathing
Martinez 2012[290]	Inappropriate reference standard – home polysomnography Inappropriate population – coronary artery disease/angina complaints
Martinez-Garcia 2018[288]	Inappropriate population – patients with resistant hypertension No relevant outcomes – no diagnostic accuracy data
Martinot 2017[293]	Inappropriate index test – Mandibular position and movements
Martinot 2017[294]	Inappropriate population – sleep disordered breathing
Martins 2020[295]	no relevant outcomes -sensitivity and specificity not reported
Marti-Soler 2016[287]	Inappropriate population – sleep disordered breathing
Masa 2011[299]	patients randomised to home RP vs hospital PSG, no relevant outcomes
Masa 2013[296]	no relevant outcomes
Masa 2014 [301]	Inappropriate index test- single channel (ApneaLink; Resmed)
Masa 2011[298]	no relevant outcomes
Masa 2013[297]	no relevant outcomes
Masa 2013[300]	no relevant outcomes
Massie 2018[302]	Inappropriate index test – hospital NightOWL
Maury 2013[303]	Inappropriate index test – oximetry + nasal flow
Maury 2014[304]	Inappropriate population – sleep disordered breathing
Mayer 1998[306]	Inappropriate population – snoring or suspected OSAHS
Mayer 2019[305]	Inappropriate index test - different heart rate accelaration and pulse transit time cut-offs calculated with total sleep time, all patients underwent polysomnography
Maziere 2014[307]	Inappropriate reference standard – hospital pulse oximetry
Mazza 2017[308]	Inappropriate population – atrial fibrillation patients who received dual-chamber pacemaker No relevant outcomes – no diagnostic accuracy data

Reference	Exclusion Reason
McArdle 2000[309]	No index test – long term outcomes were assessed in people from CPAP trial
McArdle 2020[310]	inappropriate study design - non diagnostic accuracy study, study analysed performance of peripheral arterial tonometry
McCall 2009[311]	Inappropriate population – depressed patients with insomnia No usable outcomes – no diagnostic accuracy data
McCarter 2014[312]	Inappropriate index test – study analysed RSWA phasic burst durations
McIsaac 2015[313]	Inappropriate study design - accuracy of case-ascertainment algorithms for identifying patients with OSA
McMahon 2017[314]	Inappropriate index test – STOP-BANG and Berlin questionnaires Inappropriate population – Sleep disordered breathing patients
McMillan 2015[315]	Inappropriate study design – health technology assessment
Medarov 2020[316]	Inappropriate reference standard - home polysomnography vs hospinal polysomnography
Mehra 2008[317]	Inappropriate index test-– wrist actigraphy. Inappropriate population -sleep disordered breathing
Meissner 2014[318]	Inappropriate study index test – multiple system atrophy/ home RP (oximetry, nasal flow, abdominal movements) polysomnography performed after 4 weeks.
Mendelson 1994[319]	Inappropriate study design – not a diagnostic accuracy study
Mendez 2010[320]	Inappropriate index test - ECG based on empirical mode decomposition and wavelet analysis
Meng 2016[321]	Inappropriate index test - micromovement sensitive mattress
Mergen 2019[322]	No relevant outcomes - specificity was not reported
Mesquita 2012[323]	Inappropriate index test – respiratory sounds
Methipisit 2016[324]	Inappropriate index test – linguistic validation of THAI version ESS questionnaire
Meurgey 2018[325]	Inappropriate population – sleep disordered breathing in bariatric patients
Michaelson 2006[326]	Inappropriate index test – SNAP testing

Reference	Exclusion Reason
Mihaicuta 2017[327]	Inappropriate study design – not diagnostic accuracy study, patient network analysis
Miller 2018[328]	Inappropriate analysis – unclear calculations
Miller 2018[329]	Systematic review - references checked
Minic 2014[330]	Inappropriate population - Sleep disordered breathing in group 1 pulmonary arterial hypertension
Miyata 2020[331]	inappropriate index test - sheet like device called SD 102 with SPO2 monitoring
Mokhlesi 2007[332]	No index test – prevalence in OHS was measured in the population with confirmed OSA
Morales 2012[333]	Inappropriate index test – single channel ResCare AutoSet
Morales Divo 2009[334]	Inappropriate index test - ApneaGraph
Morgan 2010[335]	No index test. Inappropriate population - Effects of Sleep-disordered Breathing on Cerebrovascular Regulation
Morgenstern 2010[337]	No index test. Inappropriate population – study assessed automatic differentiation of central hypopnea
Morgenstern 2013[336]	Inappropriate index test – nasal airflow
Morillo 2009[339]	Inappropriate index test - Poincare analysis of an overnight arterial oxygen saturation
Morillo 2013[338]	Inappropriate study design - Probabilistic neural network approach for the detection
Moro 2016[340]	Inappropriate index test – economical study
Morrell 2012[341]	Inappropriate population – sleep disordered breathing
Morris 2005[342]	Inappropriate index test - acoustic rhinometry
Morris 2008[343]	Inappropriate index test – snoring severity score
Mou 2019[344]	Inappropriate index test – validation of STOP-Bang among clinically referred patients and tested alternative scoring designs on tool performance, with a focus on gender differences in OSA.
Mueller 2006[345]	Inappropriate index test - transthoracic impedance recording integrated into a Holter ECG system
Mulgrew 2007[346]	Inappropriate index test - compared standard PSG with ambulatory CPAP titration in high-risk patients identified by a diagnostic algorithm.
Munoz-Ferrer 2020[347]	Inappropriate index test - the study aimed to evaluate the degree of measurement agreement between stepwise, in laboratory attended polysomnography and a home,

Reference	Exclusion Reason
	no sleep apnea test diagnostic accuracy data
Musman 2011[348]	Economic model with no new clinical evidence
Mutlu 2020[349]	No relevant outcomes- no diagnostic accuracy data
Nagappa 2015[350]	Systematic review - references checked
Nagubadi 2016[351]	Inappropriate population – sleep disordered breathing
Nahapetian 2016[352]	No index test – prevalence in OHS was measured in the population with confirmed OSA
Nakano 2004[354]	Inappropriate index test - Tracheal Sound Analysis
Nakano 2004[356]	No index test. Inappropriate comparison – BMI compared to ODI
Nakano 2007[357]	Inappropriate index test – single channel airflow signal
Nakano 2008[353]	Inappropriate index test – snoring intensity.No diagnostic accuracy data
Nakano 2014[355]	Inappropriate index test - Somnie (1 channel)
Netzer 1999[363]	Inappropriate index test – snoring sound recorded via smartphone
Nakano 2008[358]	No appropriate index test- the study aimed to evaluate the degree of measurement agreement between stepwise, in laboratory attended polysomnography and a home, no sleep apnea test diagnostic accuracy data
Narayan 2019[359]	Inappropriate index test - smartphone-recorded sounds validated by polysomnography
Ng 2007[367]	Inappropriate reference standard – home respiratory polygraphy
Ng 2008[365]	Inappropriate index test – snore signals
Ng 2009[364]	Inappropriate index test - frequencies of snore signals
Ng 2009[366]	Inappropriate index test -– snore signals
Ng 2017[371]	No appropriate index test - acoustical and perceptual impacts of changing the cross-sectional areas (CSA) of the pharynx and oral cavity on the production of snores
Ng 2019[370]	Inappropriate test - Apnea link-ox (3 channels)
Ng 2009[368]	No appropriate index test – study investigated acoustical and perceptual impacts of changing the cross sectional areas (CSA) of the pharynx and oral cavity on the production of snores
Nicholl 2012[376]	Inappropriate study design – not a diagnostic accuracy study

Reference	Exclusion Reason
Nicholl 2013[375]	Inappropriate population patients with CKD and end-stage renal disease Inappropriate reference standard –home cardiopulmonary study
Nigro 2009[377]	Inappropriate index test – hospital oximetry
Nigro 2011[384]	inappropriate test - ApneaLink (1 channel)
Nigro 2012[381]	inappropriate test - ApneaLink (1 channel)
Nigro 2012[383]	Inappropriate index test – hospital oximetry
Nigro 2015[385]	Inappropriate index test - diagnostic accuracy of autoscoring from auto-CPAP using different cut-off points
Nigro 2016[380]	Inappropriate study design – accuracy of clinical criteria to diagnose OSA and prescribe CPAP
Nigro 2011[379]	Inappropriate index test - Apnea link single channel
Nigro 2013[382]	Inappropriate test - Apnea link-ox (3 channels)
Nigro 2012[386]	Inappropriate study design- skilled observer compared to observer with no experience
Nigro 2010[387]	Inappropriate index test –ApneaLink 1 channel
Nigro 2019[378]	Inappropriate index test - pulse oximetry recorded from hospital polysomnography
Niijima 2007[388]	Inappropriate population- Not OSAHS. not diagnostic accuracy study
Nilius 2017[389]	Inappropriate study design – not diagnostic accuracy study, study assessed diagnostic agreement between PSG vs PDX
Nishiyama 2014[390]	Inappropriate index test – polysomnography recordings
Norman 2017[391]	Inappropriate comparison – Polysomnography at home vs polysomnography in hospital
Novkovic 2019[392]	no relevant outcomes - no diagnostic accuracy data
O'Brien 2007[393]	Inappropriate study design – conference paper on ECG derived respiratory signals
O'Driscoll 2013[394]	No relevant outcomes - accuracy data for determination of sleep and wake between SenseWear and PSG
Oeverland 2002[395]	Inappropriate population – Sleep disordered breathing
Oktay 2011[396]	inappropriate test - ApneaLink-ox (1 channel)
Oliveira 2012[397]	Inappropriate index test – Stardust, 3 channel portable recorder
Oliveira 2015[398]	Inappropriate index test – Stardust II 3 channel recorder

Reference	Exclusion Reason
Olson 1999[399]	Inappropriate index test – diagnostic accuracy of cumulative percentage time at SaO2 < 90% (CT90) and a saturation variability index
Onder 2012[400]	No relevant outcomes – no diagnostic accuracy data
Onen 2008[401]	Inappropriate index test - Observation-based Nocturnal Sleep Inventory
Ong 2010[402]	Inappropriate index test – simplified Stop-Bang questionnaire
Ortiz-Tudela 2014[405]	Inappropriate index test - wrist Temperature, motor Activity and body Position (TAP
Ozegowski 2007[406]	Inappropriate index test - ambulatory ECG
Ozmen 2011[407]	Inappropriate index test – sleep strip, 3 channels
Pallin 2014[408]	Inappropriate index test – SleepMinderTM biomotion sensor
Pamidi 2011[409]	No usable outcomes – no diagnostic accuracy data
Panchasara 2017[410]	Inappropriate study design – not diagnostic accuracy study
Pang 2006[411]	Inappropriate index test - SleepStrip
Pang 2007[412]	No usable outcomes – prevalence not reported
Park 2015[413]	Inappropriate index test – polysomnography automated vs polysomnography manual methods
Park 2015[414]	Inappropriate population – sleep disordered breathing
Parra 1997[415]	No usable outcomes – diagnostic accuracy presented on a ROC curve only
Passali 2011[416]	No usable outcomes – no diagnostic accuracy data
Pataka 2014[417]	Inappropriate index test - questionnaires
Pataka 2016[420]	Inappropriate analysis - unclear calculation methods used, sensitivity and specificity was calculated including symptoms however it is unclear from the paper how those symptoms were used
Pataka 2019[418]	Inappropriate index test - questionnaires
Pataka 2020[419]	Inappropriate reference standard - Embla Embletta® GOLD Portable respiratory polygraphy REI>15
Patout 2020[421]	Inappropriate index test - patients randomised to automised expiratory positive airway pressure (AVAPS-AE) or pressure support ventilation (ST)

Reference	Exclusion Reason
Peker 2018[422]	No usable outcomes - no diagnostic accuracy data
Pelletier-Fleury 2001[423]	Inappropriate index test – home polysomnography
Penacoba 2020[424]	Inappropriate study design - non diagnostic accuracy study, diagnostic agreement between primary and specialized care was measured
Peng 2018[425]	Inappropriate population – suspected sleep disordered breathing
Penzel 2002[426]	Inappropriate population - patients with obstructive sleep apnea and arterial hypertension
Penzel 2004[427]	No relevant outcomes – no diagnostic accuracy data
Penzel 2004[428]	Inappropriate study design – conference paper
Pepin 2009[429]	Inappropriate index test - ECG Holter device including a nasal pressure
Peto 2017[431]	Inappropriate index test – Brussels questionnaire
Phua 2020[432]	Inappropriate study design - Study investigated if WatchPat reduces time to diagnosis and treatment, no diagnostic accuracy study
Pichel 2006[433]	No usable outcomes – No diagnostic accuracy data
Pietzsch 2011[434]	Economic model with no new clinical evidence
Pihtili 2017[435]	Inappropriate study design – not a diagnostic accuracy study, study investigatedfrequency of predictors of OHS in obese patients
Pillar 1994[436]	No usable outcomes – diagnostic accuracy of OSA predictions made from questionnaires, clinical interviews and physical examinations
Pinna 2014[437]	Inappropriate population – sleep disordered breathing in heart failure patients
Pinto 2015[438]	Inappropriate index test – peripheral arterial tonometry
Pissulin 2018[439]	Inappropriate index test – questionnaires in overlap syndrome
Pittman 2004[440]	Inappropriate index test – home and hospital watchPAT 100
Pittman 2004[441]	Inappropriate index test - Polysomnography
Planes 2010[442]	Inappropriate comparison – automatic polysomnography scoring compared to manual scoring polysomnography at home

Reference	Exclusion Reason
Popovic 2009[444]	Inappropriate index test – ARESTM Unicorder, Advanced Brain Monitoring.no diagnostic accuracy data
Pouliot 1997[445]	No relevant outcomes
Poupard 2012[446]	Inappropriate index test- - ECG Holter monitor. inappropriate population -sleep disordered breathing
Poupard 2012[447]	Inappropriate index test – hospital oximetry
Pradhan 1996[448]	Inappropriate index test – Pittsburgh sleep quality index
Prasad 2017[449]	Inappropriate index test - questionnaires
Prikladnicki 2018[450]	Inappropriate index test - Orofacial Myofunctional Evaluation with Scores
Quaranta 2016[451]	Inappropriate reference standard - Somnea, polygraphy
Quintana-Gallego 2004[452]	Inappropriate population – sleep disordered breathing in heart failure
Rajeswari 2020[453]	Inappropriate study design - not a diagnostic accuracy study, different questionnaires were compared, no polysomnography
Randerath 2013[454]	Inappropriate index - oesophageal manometry
Rashid 2020[455]	systematic review references checked
Rathnayake 2010[456]	Inappropriate index test– single channel airflow measurement . Inappropriate population -sleep disordered breathing
Rauhala 2009[457]	Inappropriate index test - Periodic limb movement screening
Rauscher 1993[458]	Inappropriate index test – hospital oximetry
Ravelo-Garcia 2014[459]	Inappropriate index test – electrocardiogram
Raymond 2003[460]	Inappropriate index test - Combined index of heart rate variability and oximetry, hospital setting
Rebelo-Marques 2018[461]	Inappropriate index test – Portuguese version of Stop Bang questionnaire
Reda 2001[462]	Inappropriate index test - pharyngo-esophageal manometry.
Rees 1998[463]	No relevant outcomes – no diagnostic accuracy data
Reis 2015[465]	Inappropriate index test - Portuguese version of the STOP-Bang questionnaire
Reisch 2000[466]	Inappropriate comparison – forced oscillation techniques compared to three standard polysomnographic signals
Reuven 2001[467]	No relevant outcomes - economic analysis with no diagnostic accuracy data
Roche 1999[470]	Inappropriate index test - heart rate variability
Roche 2002[469]	Inappropriate index test - ECG Holter monitoring

Reference	Exclusion Reason
Roche 2002[472]	Inappropriate index test – hospital oximetry
Roche 2004[471]	Inappropriate index test - electrocardiogram Holter monitoring
Roche 2007[468]	Inappropriate index test - electrocardiogram Holter monitoring
Rodrigues Filho 2020[473]	Inappropriate index test - oximetry of all PSG performed by the LabSono
Rodsutti 2004[474]	Inappropriate study design – not diagnostic accuracy study
Rofail 2010[477]	Inappropriate index test - single channel nasal airflow
Rofail 2010[476]	Inappropriate index test - single channel nasal airflow
Rolon 2017[478]	Inappropriate reference standard – polysomnography using only oximetry signals
Romano 2011[479]	Inappropriate index test - diurnal negative expiratory pressure test
Romem 2014[480]	Inappropriate index test – hospital oximetry
Romero-Lopez 2011[481]	Inappropriate index test – Spanish language questionnaire
Rosen 2012[482]	Inappropriate index test – patients were randomised to hospital polysomnography and portable monitoring, patients with ahi>15 started CPAP therapy
Rosen 2018[483]	Inappropriate study design - literature review
Rosenthal 2008[484]	Inappropriate index test – ESS questionnaire
Rosenwein 2015[485]	Inappropriate index test - non-contact audio recordings
Ross 1998[487]	Systematic review - references checked
Ross 2000[488]	Systematic review - references checked
Ross 2000[486]	Abstract only
Rowley 2000[489]	Inappropriate index test - Global Sleep Assessment Questionnaire
Ryan 1995[490]	Inappropriate index test
Saarelainen 2003[491]	Inappropriate index test - whole-body impedance cardiography
Saha 2020[492]	Inappropriate index test - patch wearable device used to record respiratory sounds and neck position and movement
Saleh 2011[493]	Inappropriate index test - Arabic version of Berlin questionnaire
Sangkum 2017[494]	Inappropriate study design
Santaolalla Montoya 2007[495]	Inappropriate index test – clinical prediction algorithm using various epidemiological parameters

Reference	Exclusion Reason
Saricam 2020[496]	Inappropriate reference standard - Berlin questionnaire
Savage 2016[497]	Inappropriate population – sleep disordered breathing in patients with heart failure
Scarlata 2013[498]	Inappropriate index test – ESS and PSQI questionnaires
Schafer 1997[499]	Inappropriate index test – oximetry measured with a four channel MESAM 4 device
Scharf 2004[500]	Inappropriate index test – cardiac pacemaker
Senaratna 2019[501]	Systematic review - references checked
Senn 2006[502]	Inappropriate index test – patients randomised to CPAP vs polysomnography
Sergi 1998[503]	Inappropriate comparison – daytime polysomnography was compared to daytime polysomnography
Series 1991[504]	Inappropriate comparison – daytime polysomnography was compared to daytime polysomnography
Sériès 1993[506]	Inappropriate study design - interpretation was not based on the occurrence of minimal decrease in the Sa02 level or having value below fixed threshold
Series 1999[505]	Inappropriate index test – nasal pressure tracing
Serrano 2018[507]	Inappropriate study design – clinical prediction rules were analysed
Sert Kuniyoshi 2011[508]	Inappropriate population – sleep disordered breathing in patients with a recent myocardial infarction
Sforza 2007[509]	Inappropriate study design - heart-rate variability (HRV) measures on the degree of sleep fragmentation.
Shalaby 2006[510]	Inappropriate index test - The pacemaker trans-thoracic impedance signal
Shams 2012[511]	Inappropriate index test - tracheal breath sounds
Shi 2018[512]	Inappropriate study design – conference paper, algorithm analysis
Shin 2010[513]	Inappropriate study design – algorithm analysis
Shochat 2002[514]	Inappropriate index test - SleepStrip
Shokrollahi 2016[515]	Inappropriate study design – conference paper, snoring sound analysis
Siegel 2000[516]	Inappropriate index test – ultrasonic imaging
Silva 2011[517]	Inappropriate population – sleep disordered breathing

Reference	Exclusion Reason
Sivam 2018[518]	Inappropriate index test – oximetry and transcutaneous CO2 measured during polysomnography in OHS population
Skiba 2015[519]	No index test – retrospective review of Polysomnography results
Skomro 2007[520]	Inappropriate study design - retrospective study of all patients who had been offered empirical CPAP therapy for suspected OSA was conducted.
Smith 2020[521]	Inappropriate index test- 2 channel apnealink tm, oximetry and nasal flow
Sola-Soler 2007[524]	Inappropriate study design – conference paper
Sola-Soler 2012[522]	Inappropriate index test - snoring analysis
Sola-Soler 2014[523]	Inappropriate index test - tracheal breath sound analysis
Sommermeyer 2012[525]	No index test – cardiorespiratory polygraphy was used,
Song 2016[526]	Inappropriate study design - Markov model from ECG Signals
Stein 2003[527]	Inappropriate index test- Holter recordings
Stelmach-Mardas 2017[528]	Inappropriate index test – Berlin questionnaire
Stendardo 2018[529]	Inappropriate study design – not diagnostic accuracy study
Stoohs 1990[531]	Inappropriate index test – MESAM device
Stoohs 1992[532]	Inappropriate index test – MESAM device
Su 2004[534]	Inappropriate index test – SNAP digital recorder
Su 2012[533]	No usable outcomes – no diagnostic accuracy data
Subramanian 2011[535]	Inappropriate index test – NAMES assessment
Suksakorn 2014[536]	Inappropriate index test – Thai version of Berlin questionnaire in patients with sleep disordered breathing
Sun 2011[537]	Inappropriate study design – artificial intelligence method to screen OSA
Sun 2019[538]	inappropriate study design - patients completed, home portable monitoring and echocardiography
Takama 2010[539]	Inappropriate population – sleep disordered breathing in patients with cardiovascular disease
Takeda 2006[540]	Inappropriate index test – Apnomonitor III test, not oximetry alone
Tanaka 2009[541]	No usable outcomes – no diagnostic accuracy data
Tauman 2006[542]	No usable outcomes no diagnostic accuracy data

Reference	Exclusion Reason
Teferra 2014[543]	Inappropriate study design – analysis of artificial neural network sleep apnea tool for sleep studies
Teklu 2020[544]	Inappropriate study design/inappropriate comparison- no diagnostic accuracy data
Teramoto 2002[545]	Inappropriate index test – hospital oximetry
Terjung 2016[547]	Inappropriate population - mixed OSA and PLM population
Terjung 2018[546]	Inappropriate index test – VitaLog, no diagnostic accuracy data
Thong 2008[548]	No relevant outcomes – no diagnostic accuracy data
Thornton 2012[549]	No index test - previously scored polysomnography was reviewed
Tian 2005[550]	Inappropriate study design conference paper
Tiihonen 2009[551]	Inappropriate reference standard – hospital polygraphy
Ting 2014[552]	Inappropriate study design – validation of prediction system to diagnose OSA
To 2012 [553]	Inappropriate index test – ARES (apnea risk evaluation system)
To 2009[554]	Inappropriate study design – CPAP compared with portable sleep monitoring
Tong 2014[555]	Inappropriate index test - ECG derived respiration
Topor 2020[556]	Inappropriate index test - MATRx plus (ZephyrSleep Technologies) - level 3 device cosists of microphone and accelerometer
Traxdorf 2017[557]	Inappropriate index test – Erlangen questionnaire
Tsai 2003[558]	Inappropriate index test – decision rule (cricomental space, pharyngeal grade)
Tsukahara 2014[559]	Inappropriate index test – sheet type portable monitor SD-101
Ugon 2016[560]	No relevant outcomes – no diagnostic accuracy study
Ulasli 2014[561]	Inappropriate index test – Berlin and ESS questionnaires
Unal 2002[562]	Inappropriate index test – polysomnography recordings were analysed
Ustun 2016[563]	Inappropriate index test – SLIM and 7 state of the art classification methods
Valipour 2007[564]	No relevant outcomes – no diagnostic accuracy data
Van Brunt 1997[565]	Inappropriate index test – snoring sounds
Van Meerhaeghe 2004[566]	Inappropriate index test – NEP (negative pressure) procedure
Van Surell 1995[567]	Inappropriate Index test – CID 102 device

Reference	Exclusion Reason
Vana 2013[568]	Inappropriate study design – artificial neural networks for the recognition of three different patterns in the respiration signals were analysed
Varady 2002[569]	No relevant outcomes – no diagnostic accuracy data
Vaughan 2016[570]	Not in English
Vaz 2011[571]	Inappropriate index test – hospital oximetry
Vazquez 2000[572]	Inappropriate index test - hospital oximetry
Ventura 2007[573]	Inappropriate Index test – CID 102 device
Victor Marcos 2008[574]	Inappropriate index test – oxygen saturation recordings were used. The performance of two different ensemble classifiers was analysed.
Virkkula 2002[576]	No usable outcomes – no diagnostic accuracy data
Virkkula 2005[575]	No usable outcomes – no diagnostic accuracy data
Wang 2014[577]	No usable outcomes – no diagnostic accuracy data
Ward 2009[578]	Abstract only
Ward 2012[580]	Inappropriate index test - Hospital oximetry
Ward 2015[579]	Inappropriate test - ApneaLink (3 channels)
Weinreich 2008[581]	Inappropriate population – 11 patients with OSA, 10 with hypopnea, 11 with Cheyne-Strokes respiration and 5 with normal breathing
Weinreich 2014[582]	Inappropriate index test – SleepMinder
Westerlund 2014[583]	Inappropriate index test - non-contact device emits a very weak electromagnetic radiation and detects body movement by measuring the Doppler effect
White 1994[585]	Inappropriate index test - Karolinska Sleep Questionnaire
White 1995[584]	Inappropriate index test - sound recording and oxygen saturation
Whitelaw 2005[586]	Inappropriate index test - Healthdyne NightWatch (NW) System
Wieczorek 2018[587]	Inappropriate index test – PADSS (Paris Arousal Disorder Severity Scale)
Williams 1991[588]	Inappropriate index test – hospital oximetry + clinical score
Williams 2017[589]	No usable outcomes – no diagnostic accuracy data
Wong 2008[591]	Inappropriate index test – nasal flow monitor
Wu 2017[592]	Inappropriate index test – fuzzy evaluation system (NFES)
Wu 2020[593]	no relevant outcomes - no diagnostic accuracy data

Reference	Exclusion Reason
Xie 2012[594]	Inappropriate index test – ECG and Peripheral SpO2 from polysomnography
Xie 2020[595]	Inappropriate index test - Data were collected using Brief ICF-Sleep Disorders and Obesity Core Set
Xiong 2019[596]	Inappropriate index test - questionnaire
Yaddanapudi 2018[598]	Inappropriate population– stroke patients who underwent HRPO, no diagnostic accuracy. no relevant outcomes data
Yagi 2009[599]	No usable outcomes – Only sensitivity and positive predictive values presented in the paper
Yalamanchali 2013[600]	Systematic review - references checked
Yamaguchi 2007[601]	Inappropriate index test - SleepStrip
Yamashiro 1995[602]	Inappropriate population – Sleep disordered breathing
Yang 2011[603]	Inappropriate index test - plethysmography
Yang 2013[604]	Inappropriate study design – literature review
Yin 2005[606]	No relevant outcomes – no diagnostic accuracy data
Yin 2006[605]	No usable outcomes – study reported only sensitivity and positive predictive value, prevalence unclear
Yuceege 2014[608]	Inappropriate index test - neck/thyromental distance
Yousif 2020[607]	Inappropriate comparison/ inappropriate index test/inappropriate reference standard- index test HCO3 and reference standard polysomnography
Yuceege 2015[609]	Inappropriate index test – Turkish version Berlin questionnaire + gender
Yunus 2013[610]	Inappropriate index test – Malay version of Berlin questionnaire
Zaffaroni 2009[611]	Inappropriate index test – SleepMinder
Zaffaroni 2013[612]	Inappropriate index test – SleepMinder
Zamarron 1999[616]	Inappropriate index test – hospital oximetry
Zamarron 2001[615]	Inappropriate index test – hospital oximetry
Zamarron 2003[613]	Inappropriate index test – hospital oximetry
Zamarron 2006[614]	Inappropriate index test – hospital oximetry
Zarei 2018[617]	Inappropriate index test - Single-Lead ECG Signal.
Zhang 2011[618]	Inappropriate population– sleep disordered breathing.no diagnostic accuracy data no relevant outcomes
Zhang 2018[619]	Not in English
Zhou 2020[620]	Inappropriate index test - questionnaire
Zhu 2020[621]	Inappropriate index test - patch wearable device used to record respiratory sounds and neck position and movement

Reference	Exclusion Reason
Zou 2013[622]	Inappropriate index test – ESS questionnaire (cut off 9)
Zou 2015[623]	Inappropriate index test - The SleepView device is a 2-channel diagnostic tool designed for screening of sleep-disordered breathing
Zucconi 1996[624]	Inappropriate index test - unattended recording device (MicroDigitrapper-S) (M-S).
Zywietz 2004[625]	Inappropriate index test - single channel ECG

J.2 Excluded health economic studies

Published health economic studies that met the inclusion criteria (relevant population, comparators, economic study design, published 2003 or later and not from non-OECD country or USA) but that were excluded following appraisal of applicability and methodological quality are listed below:

Table 27: Studies excluded from the health economic review

Reference	Reason for exclusion
Alonso Alvarez 2008[24]	This study was assessed as partially applicable with potentially serious limitations. However, the committee judged that other available evidence by Corral 2017[93] was of greater methodological quality as it considered downstream health and cost consequences following the diagnostic test.
Andreu 2012[37]	This study was assessed as partially applicable with potentially serious limitations. However, as QALYs cannot be calculated, the committee judged that other available evidence by Corral 2017[93] was of greater methodological quality.
Hernandez-Bendezu 2018[169]	This study was assessed as having very serious limitations. The study did not use randomised evidence. Furthermore it did not calculate health outcomes and was conducted from a Mexican perspective.
Hui 2017[175]	This study was assessed as partially applicable with potentially serious limitations. However, the committee judged that other available evidence by Corral 2017[93] was of greater applicability, since this study did not calculate QALYs and the setting was Hong Kong.
Jurado Gamez 2007[183]	This study was assessed as not applicable because the costs used in the analysis were from sources before 2003.
Masa 2011[298]	This study was assessed as partially applicable with potentially serious limitations. However, the committee judged that other available evidence by Corral 2017[93] was of greater methodological quality as it considered downstream health and cost consequences following the diagnostic test.
Masa 2013[297]	This study was assessed as partially applicable with potentially serious limitations. However, the committee judged that other available evidence by Corral 2017[93] was of greater methodological quality as it considered downstream health and cost consequences following the diagnostic test.

Reference	Reason for exclusion
Masa 2013[300]	This study was assessed as partially applicable with potentially serious limitations. However, the committee judged that other available evidence by Corral 2017[93] was of greater methodological quality as it considered downstream health and cost consequences following the diagnostic test.
Masa 2014[301]	This study was assessed as partially applicable with potentially serious limitations. However, the committee judged that other available evidence by Corral 2017[93] was of greater methodological quality as it considered downstream health and cost consequences following the diagnostic test.
Ontario Ministry of Health and Long-Term Care 2006[403]	This study was assessed as partially applicable with very serious limitations because the authors have not indicated where data for costs or outcomes have been sourced.
Phua 2020[432]	This study was assessed as partially applicable with potentially serious limitations. However, the committee judged that other available evidence by Corral 2017[93] was of greater methodological quality as it considered downstream health and cost consequences following the diagnostic test.
Steward 2017[530]	This study was assessed as partially applicable with very serious limitations because the inclusion criteria (risk of OSAHS) for separate arms of the trials are not consistent.