Prevalence of and treatment outcomes for patients with obstructive sleep apnoea identified by preoperative screening compared with clinician referrals

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ABSTRACT Obstructive sleep apnoea (OSA) has implications perioperatively. We compared the prevalence of OSA and outcome with continuous positive airway pressure (CPAP) in patients diagnosed through preoperative screening and following referrals from other clinicians.

Among 1412 patients (62% males) the prevalence of OSA, Epworth Sleepiness Score (ESS), the number referred for CPAP, and short and longer term use of CPAP were compared between the two groups.

The prevalence of OSA was similar (62% *versus* 58%). There were differences in mean±SD age (61±16 *versus* 55±13 years; p<0.0001), ESS (11±6 *versus* 8±5; p<0.0001) and oxygen desaturation index (22±20 *versus* 19±17; p=0.039). Clinician-referred patients were more likely to be offered CPAP (p<0.0001; OR 2.84). Pre-assessment patients with mild OSA were less likely to continue CPAP long term (p=0.002; OR 6.8). No difference was seen between moderate and severe OSA patients.

The prevalence of OSA was similar in both groups but pre-assessment patients were younger and less symptomatic. Preoperative screening of patients is worthwhile, independent of any effect of CPAP upon surgical outcomes; younger and less symptomatic patients are identified earlier. Pre-assessment patients with mild OSA were less likely to use CPAP; this should be considered when offering CPAP to these patients prior to surgery.

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Introduction

There is a high prevalence of obstructive sleep apnoea (OSA) in the general population, ranging from 9% to 24% [1–3]. This is likely to increase with changing lifestyles and the increasing incidence of obesity. OSA is often undiagnosed and is associated with high morbidity and mortality rates [4–6]. Unidentified OSA can lead to unexpected perioperative complications, unplanned postoperative admissions and increased length of hospital stays [7–10]. A diagnosis of OSA is independently associated with an increased risk of death in patients undergoing bariatric surgery [11]. Preoperative screening of all patients for OSA is recommended but this is not based on robust evidence [12–15].

In a study by Hwang *et al*. [10], the postoperative complications were proportional to the number of episodes of overnight desaturation during nocturnal oximetry. Patients with a 4% oxygen desaturation index (ODI) $\geqslant$5 had a significantly higher rate of postoperative complications than those with an ODI <5 (15.3% *versus* 2.7%, respectively; p<0.01). The complication rate also increased with increasing ODI severity (13.8% in patients with an ODI of 5–15 events per hour and 17.5% with an ODI of $\geqslant$15 events per hour; p=0.01). In another study increasing severity of OSA, age, comorbid disease and the type of surgery also predicted increased risk [16].

Continuous positive airway pressure (CPAP) is the gold standard in the management of OSA. It is the most effective treatment to improve symptoms, quality of life and to reduce long term complications. Perioperative CPAP decreases postoperative apnoea–hypopnoea index (AHI) and improves oxygen saturation in moderate to severe OSA [17]. In a large cohort study which compared postoperative outcomes, there was an increased incidence of cardiovascular complications, primarily cardiac arrest and shock, in undiagnosed OSA but not in those diagnosed who were treated with CPAP [16]. In another study OSA patients who were not compliant with CPAP had the highest rate of postoperative complications [18]. There may therefore be an advantage to establishing patients on CPAP prior to surgery, though this needs to be confirmed in a prospective randomised controlled trial.

Assessing all patients going for surgery who might have OSA in a sleep clinic would put a very large extra burden on services already struggling to meet demand. We evaluated the use of a simple screening questionnaire, CPAP treatment outcome and long term compliance in patients diagnosed through preoperative screening and compared it with patients diagnosed following referrals from general practice or other clinicians.

Methods

All patients referred from other clinicians (general practitioners (GPs) and other hospital specialists) and from the surgical pre-assessment clinics who underwent a sleep study (October 2009 to 2011) were retrospectively identified from a database. Patients at the pre-assessment clinics were seen by a qualified nurse and completed a locally agreed questionnaire (supplementary material), which included the Epworth Sleepiness Score (ESS), severity of snoring, frequency of choking and apnoeic episodes witnessed by the bed partner. All patients meeting at least two criteria (body mass index >30, neck size >44 cm, hypertension, ESS >13, extremely loud snoring, nocturnal choking or witnessed apnoeas more than three times a week) were referred for a sleep study, usually overnight oximetry or sometimes a limited channel respiratory variable sleep study (Embletta; ResMed, Abingdon, UK). Patients in whom OSA was diagnosed on the sleep study were offered an appointment in the sleep clinic *via* their GP.

The database included information on patient demographics, data from each diagnostic or titration study, CPAP trial and annual CPAP review. All personal patient identifiable data was removed. Information regarding the demographics, route of referral (either from surgical pre-assessment clinics or referrals from another hospital clinician or a GP), sleep study results, treatment outcome and CPAP compliance at 1 year were obtained. Patients were classified into two groups, clinician referrals and pre-assessment referrals. OSA severity (based on ODI during the diagnostic study) and/or patient's symptoms and quality of life were considered before offering a CPAP trial.

CPAP treatment

Patients with moderate OSA (ODI 16–30 events per h) and severe OSA (ODI >30 events per h) were offered a trial of CPAP whether or not they perceived that they had significant symptoms. Patients with mild OSA (ODI 5–15 events per h) were only offered a trial of CPAP if they had symptoms which had an impact on quality of life and daytime function as recommended by the National Institute of Clinical Excellence [19]. Other factors such as occupation, driving behaviour and patient's expectation were also considered. CPAP was offered as the first choice treatment. An autotitrating or fixed pressure (depending on availability) [20] CPAP trial was initiated by a specialist nurse after a one-to-one training session covering appropriate mask and head gear, rationale, benefits and possible side-effects, followed by a clinical review after 2–4 weeks. Some patients were offered an extension of the trial if they developed a problem or had severe symptomatic disease, had struggled with CPAP initially and were motivated to

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continue. During this period patients were offered any of the following if considered appropriate: a different mask or humidifier, or lower CPAP pressure. Patients who did not want to continue CPAP at the end of the trial are described as "CPAP declined". Patients using the CPAP machine for more than 2 h per night on average were considered to have "satisfactory" levels of use [21], but were encouraged to increase their usage to at least 4 h per night. Long term CPAP was initiated, usually with a fixed pressure machine, unless there was considerable variation in CPAP pressures during the autotitrating trial, if the patient had a subjective improvement, improved ESS and was willing to continue CPAP. Patients who were initiated on long term CPAP had a telephone consultation after 3 months and then an annual review, both by clinical nurse specialists. Further clinic visits were arranged if problems were identified. Patients could access telephone support outside of scheduled visits and were encouraged to contact the nurse specialist for any CPAP related problems.

Subjective sleepiness

Subjective sleepiness was assessed by the ESS at the time of CPAP initiation, telephone consultation at 3 months and during the annual review.

Statistical analysis

The statistical analysis was carried out using Graph Pad Prism 6 software (San Diego, CA, USA). Statistical significance was set at $p<0.05$. Values are presented as mean±SD for normally distributed data. Chi-square test was used to compare the CPAP declined rate and the long term CPAP use between the two groups. Non-parametric analyses were used for the duration of CPAP usage and are presented as median (interquartile range (IQR) and range). Unpaired t-test was used to compare the subjective improvement in ESS.

Results

Over a period of 2 years 1511 patients had a sleep study. Studies done on patients who were already established on CPAP or NIV for various other reasons, and failed or inconclusive studies, were excluded. 1412 patients were included in the final analysis.

Patient demographics

The baseline characteristics of the study population are listed in table 1.

OSA prevalence and treatment outcome

The prevalence of OSA was 58% among the patients referred from the pre-assessment clinic after opportunistic screening and 62% among the patients referred from clinicians who had a clinical suspicion of OSA. The severity of OSA in the respective groups and the clinical outcome are listed in the CONSORT flow diagram (figure 1). Clinician referred patients were more likely to be commenced on CPAP ($p<0.0001$; OR 2.84, 95% CI 2.1–3.7). On subgroup analysis, mild OSA patients referred from a clinician were more likely to be considered for a CPAP trial as compared to patients referred from pre-assessment ($p<0.0001$; OR 4.3, 95% CI 2.7–6.9). There was no difference in the moderate and severe OSA patients in both the groups.

CPAP trial outcome

Patients who had a CPAP trial were categorised as CPAP "declined" or "accepted" at the end of the trial; the results in each group according to the severity of OSA are shown in table 2.

Patients with mild OSA referred from pre-assessment were more likely to decline a CPAP trial as compared to patients referred from clinicians. There was no difference in the moderate and severe category. A proportion of patients referred from a clinician in the moderate (n=26, 43%) and severe (n=26, 29%) OSA category declined long term CPAP. On further investigation, patients in the moderate OSA

TABLE 1 Patient demographics

	Pre-assessment referrals	Clinician referrals	p-value
Age years	55±13	61±16	<0.0001
BMI kg·m^{-2}	36±8	35±6	0.95
ESS at diagnosis	8±5	11±6	<0.0001
ODI at diagnosis	19±17	22±20	0.039

Data are presented as mean±SD, unless otherwise stated. BMI: body mass index; ESS: Epworth Sleepiness Score; ODI: oxygen desaturation index.

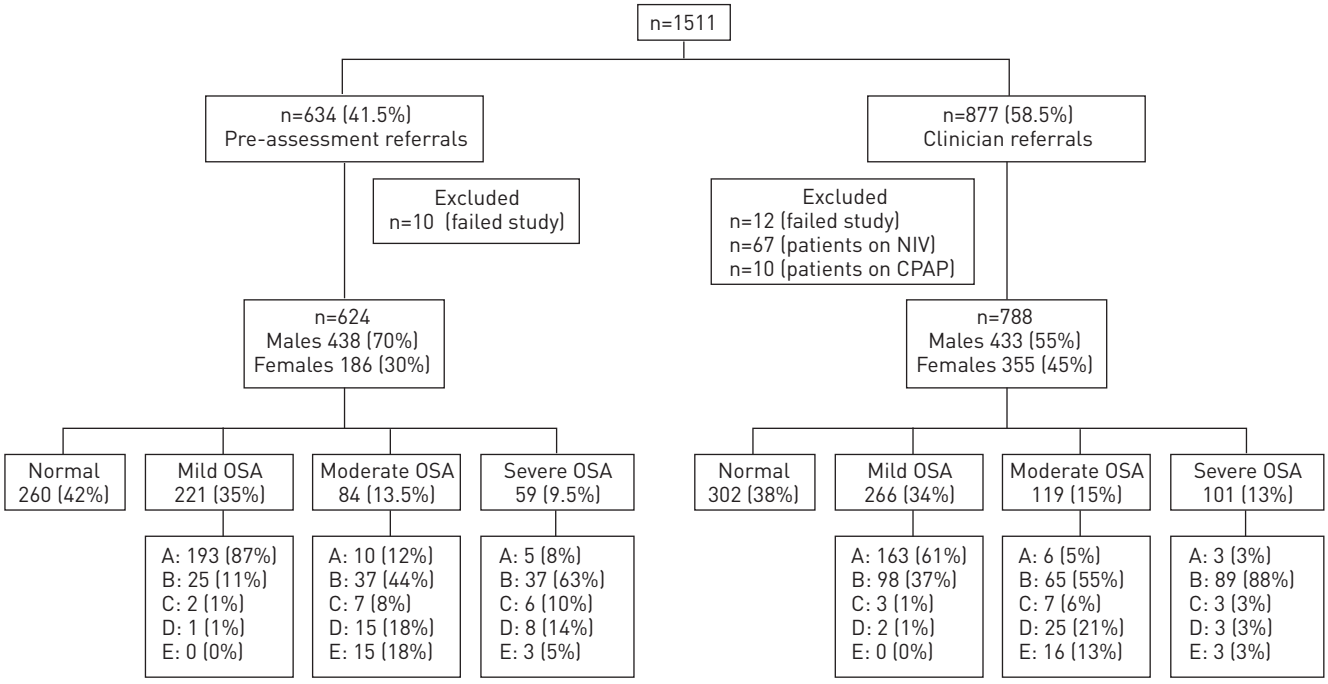

FIGURE 1 CONSORT flow diagram. NIV: noninvasive ventilation; CPAP: continuous positive airway pressure; OSA: obstructive sleep apnoea. A: non-CPAP treatment; B: CPAP treatment; C: did not attend sleep clinic; D: attended sleep clinic but declined CPAP trial; E: attended sleep clinic but did not attend CPAP trial.

category who declined CPAP were less symptomatic compared to those who accepted long term CPAP (p=0.0075; mean±SD ESS 8±5 and 12±5). In the severe OSA group, CPAP was trialled as an inpatient treatment in six patients (four post-stroke and two with severe pneumonia); all of these declined long term CPAP. There was no significant difference in the ESS between those who accepted and those who declined (p=0.94; mean±SD ESS 12±6 and 12±5), respectively.

CPAP adherence at 1 year

Patients who had a successful trial ("accepted" group) of CPAP were established on long term CPAP treatment. These patients were followed up and were reviewed at 1 year. Patients with mild OSA referred from pre-assessment were more likely to stop CPAP within 1 year compared to patients referred from clinicians (63% *versus* 20%) and, if using, were less likely to continue CPAP long term compared to patients referred from clinicians (37% *versus* 80%) (p=0.002; OR 6.8, 95% CI 1.7–26.8). There was no difference in the moderate or severe category (table 3).

CPAP usage and compliance

Among patients who were established on long term CPAP, at 1 year there was a significant difference in the median CPAP usage: 5.5 h *versus* 4 h between the patients referred from clinicians and pre-assessment (figure 2).

TABLE 2 Continuous positive airway pressure (CPAP) trial outcome

	Pre-assessment referrals	Clinician referrals	p-value; OR (95% CI)
Mild OSA			
CPAP declined	14 (56%)	29 (30%)	0.01; 3.0 (1.2–7.4)
CPAP accepted	11 (44%)	69 (70%)	
Moderate OSA			
CPAP declined	13 (31%)	26 (43%)	0.62; 0.81 (0.35–1.8)
CPAP accepted	24 (69%)	39 (57%)	
Severe OSA			
CPAP declined	7 (19%)	26 (29%)	0.23; 1.76 (0.69–4.5)
CPAP accepted	30 (81%)	63 (71%)	

OSA: obstructive sleep apnoea.

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TABLE 3 Short and longer term continuous positive airway pressure adherence in the two groups

	Pre-assessment referrals	Clinician referrals	p-value; OR (95% CI)
Mild OSA			
<1 year	7 (63%)	14 (20%)	0.002; 6.8 (1.7–26.8)
>1 year	4 (37%)	55 (80%)	
Moderate OSA			
<1 year	8 (37%)	5 (13%)	0.06; 3.4 (0.95–12)
>1 year	16 (67%)	34 (87%)	
Severe OSA			
<1 year	6 (20%)	6 (10%)	0.15; 0.42 (0.12–1.4)
>1 year	24 (80%)	57 (90%)	

OSA: obstructive sleep apnoea.

On subgroup analysis, mild OSA patients who were on long term CPAP referred from the pre-assessment services were found to have a low median usage of 2.1 h (IQR 1.1–2.6, range 0.5–6.6) as compared to 5.9 h (IQR 4.2–6.6, range 0.2–8.9) from patients referred from clinicians. There was no difference in the moderate OSA referred from pre-assessment (median 4.7 h, IQR 2.3–5.9, range 0.1–8.8) and the clinician (median 4.7 h, IQR 2.6–6.4, range 0.2–8.0). Similarly, there was no difference in the severe OSA group referred from pre-assessment (median 4.8 h, IQR 3.3–6.5, range 0.1–10.1) and the clinician (median 5.5 h, IQR 3.1–7.9, range 0.1–10.5) in both the groups, respectively.

Subjective sleepiness

For those patients on CPAP at 1 year there was a significant improvement in ESS with CPAP in both the clinician-referred and pre-assessment patients respectively (change in ESS 5 and 4; p<0.0001) (figure 3).

Discussion

Data on prevalence and objectively assessed long term CPAP compliance in patients undergoing surgical interventions identified through opportunistic preoperative screening is limited and this study highlights the importance of "preoperative screening" to identify OSA. This was a retrospective assessment of OSA diagnosis and CPAP adherence in two hospital-based populations; one being part of a preoperative assessment service and the second being a standard referral-based sleep clinic.

In our study the prevalence of OSA in the patients referred from other clinicians and pre-assessment was 62% and 58% respectively. This suggests that questionnaire screening is as effective as non-specialists in selecting patients for further investigation. Patients with mild OSA referred from pre-assessment as compared to other clinicians were less likely to be offered a CPAP trial (11% *versus* 37%), if offered a CPAP trial, were more likely to decline it (56% *versus* 30%), and if they did accept were more likely to discontinue CPAP within 1 year. The median CPAP adherence in this group was low (2.1 h *versus* 5.9 h). By contrast

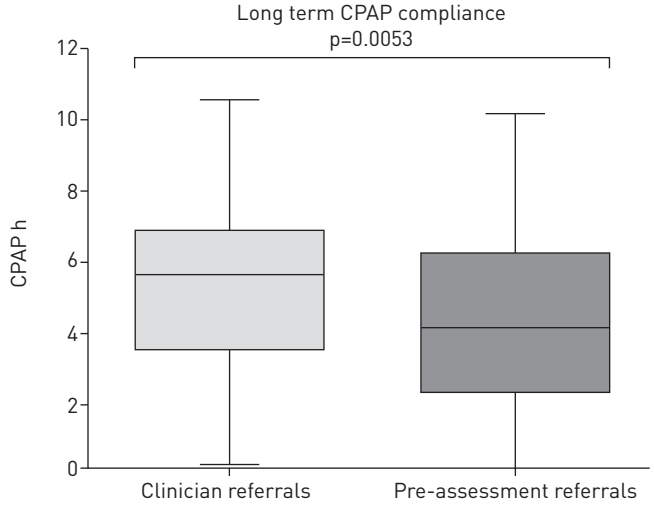

FIGURE 2 Median continuous positive airway pressure (CPAP) use in the two groups.

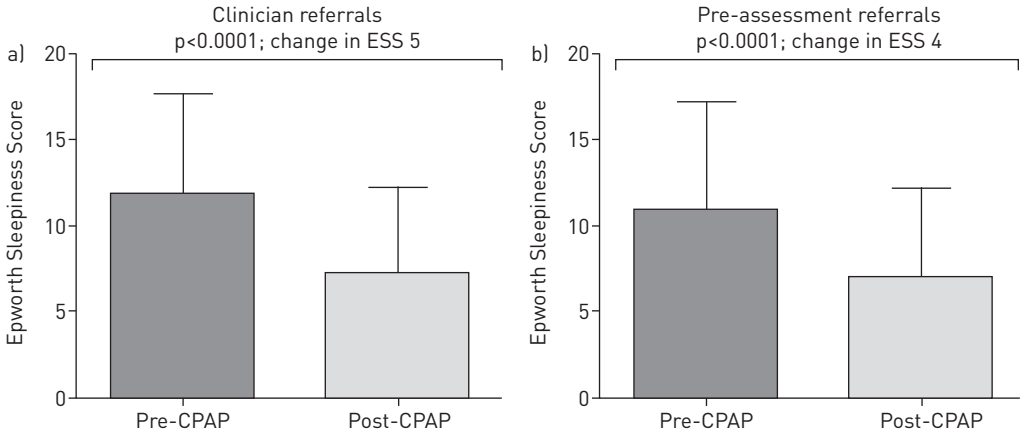

FIGURE 3 Epworth Sleepiness Score (ESS) prior to continuous positive airway pressure (CPAP) and at 1 year in the two groups.

patients with moderate to severe OSA exhibited similar CPAP adherence (4.7 h *versus* 4.7 h) and (4.8 h *versus* 5.5 h) respectively and this was better compared to a previous study [17]. There was a subjective improvement in daytime sleepiness in both the clinician-referred and pre-assessment groups.

Clinician-referred patients usually believe they have a problem and referral is more likely to be a patient initiated process; this probably explains why they are more likely to be offered treatment and, if offered it, are more likely to try it and accept it in the long term. In contrast, patients referred from the pre-assessment clinics do not necessarily perceive that they have a problem with sleep disordered breathing; their main interest is the planned surgery. This probably explains why they are less likely to accept a CPAP trial offer, less likely to accept longer term treatment and more likely to stop it subsequently. Accepting CPAP just to facilitate surgery may explain the worse 1 year adherence in the pre-assessment referred patients who accepted CPAP. Moderate and severe OSA patients identified through surgical pre-assessment clinics had similar uptake of CPAP to those referred by conventional routes and were on average 6 years younger at the time they started CPAP. This may have the important consequence of reducing vascular risk earlier than would be the case by waiting until patients are sufficiently symptomatic that they seek help for themselves [22], though this has not been confirmed in a randomised controlled trial.

Our study had some limitations. First, this was a retrospective observational study. Some data were missing, including the total number of patients screened in the pre-assessment clinic to generate a population of 624 patients and how rigidly the in-house questionnaire was adhered to. We think it is unlikely, because of hospital processes, that patients with a positive questionnaire would have had surgery without a sleep study. The screening in the pre-assessment clinics is carried out by nurses; they would not make decisions about referral for a sleep study or surgery independently of the questionnaire. We do not think that there was any second filter determining who was sent for a study. Secondly, patients in the pre-assessment clinics were not identified using a validated questionnaire; however our in-house questionnaire was similar to STOP-Bang and the pickup rate for OSA was very similar to that achieved with STOP-Bang [15]. However, our questionnaire has not been validated and has not been compared with STOP-Bang. Thirdly, we do know the type of surgical intervention for each patient and whether this could have affected OSA, but think it is very unlikely; surgery, with the exception of tracheostomy, is not an effective treatment for OSA. Fourthly, review in the sleep clinic for the pre-assessment patients required a referral from the GP and this could have led to a bias in patients sent for CPAP. The GP was made aware that OSA had been identified as part of preoperative assessment; we think it unlikely that they would not have referred for further evaluation when the issue appeared to be related to safety of an anaesthetic and surgery. Furthermore, they would have been more likely not to send the less symptomatic patients, so it is likely that our observation that patients picked up through preoperative screening tend to be less symptomatic would if anything be stronger. It could be argued that it was the sleep service "process" rather than the patients that were different. We do not think that this is likely. The pick-up rate for OSA was similar in the two groups. It is possible that patients with mild disease might be more likely to be offered CPAP because of the perceived adverse effect of untreated OSA upon peri-operative outcome and that this lower threshold explains the lower short and long term uptake. In fact, pre-assessment patients with mild disease were less likely to be offered CPAP, so this cannot be the explanation.

Despite these limitations, several novel results emerged from this analysis. We have shown that the prevalence of OSA in patients undergoing surgical intervention is high and these patients can be identified

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through preoperative screening. Patients diagnosed by this method tend to be younger and less symptomatic. Pre-assessment patients with mild OSA are less likely to use CPAP in the short or longer term. This should be taken into account when considering initiating CPAP prior to surgery. The study by HWANG *et al.* [10] suggests that even mild OSA should be treated, at least in the perioperative period but this will require a randomised trial. Our data suggest that these patients may require additional input if they are to use CPAP satisfactorily even for this short period. For patients with moderate and severe OSA, CPAP uptake and adherence is comparable to patients referred by clinicians. There is no justification for denying symptomatic patients CPAP just because they have been identified during pre-assessment or at the time of surgery.

Our findings imply that the number of sleep-related breathing events and severity of symptoms, irrespective of the mode of patient referral, determines long term adherence to CPAP therapy in our clinic population. This study does not address the question of whether identifying and treating patients with OSA impacts upon anaesthetic and surgical outcomes. However, preoperative assessment is still a useful opportunity for identification of OSA patients, particularly younger less symptomatic patients who might benefit from early intervention with CPAP, rather than waiting until they seek help for themselves.

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