Nasal continuous positive airway pressure treatment for obstructive sleep apnoea

Ronald R Grunstein

In 1984 Bradley and Phillipson wrote an editorial reviewing the early data from surgical and non-surgical treatments for sleep apnoea entitled “Therapy for sleep apnoea, separating the wheat from the chaff”. At that time one anonymous humorist (well versed with 1960s American vernacular) photocopied the editorial and placed it on a department notice board in a Sydney hospital with an added comment to the title, “Which treatment will make the most ‘bread’?” The answer to this “revised” editorial title is that it was estimated that, in 1993, over 100 000 nasal continuous positive airway pressure (CPAP) units were sold worldwide – a health care expenditure of approximately US$ 100 million for equipment alone. After a decade of controversy over the relative benefits of upper airway surgery and CPAP, there is now reasonable consensus that CPAP is the first choice therapy for obstructive sleep apnoea. Nevertheless, it is also recognised that CPAP is an imperfect therapy and recent studies describing the objective measurement of CPAP use in patients have revealed much lower compliance figures than those previously reported by early advocates of this form of treatment. The purpose of this brief review is to summarise recent data on the use of CPAP in obstructive sleep apnoea, practical aspects of this therapy, and future developments in “intelligent” CPAP devices and how they will impact on treatment of sleep-related breathing disorders. This review will concentrate on obstructive sleep apnoea rather than other forms of sleep-disordered breathing such as central apnoea and hypventilation in sleep. Issues such as CPAP initiation, compliance, side effects, and the approach to the patient intolerant of CPAP will be discussed.

Historical aspects and mechanism of action

The original experiments with CPAP in obstructive sleep apnoea followed from the concept that closure of the oropharynx was the result of an imbalance in the forces that normally keep the upper airway open. This concept was delineated in the model presented by Remmers et al in 1978. In the first description of CPAP use for treatment of obstructive sleep apnoea by Sullivan et al in 1981 it was suggested that nasal CPAP acts as a pneumatic splint to prevent collapse of the pharyngeal airway – that is, increasing the pressure in the oropharyngeal airway, reversing the transmural pressure gradient across the pharyngeal airway. This notion has subsequently been confirmed by a number of studies which either demonstrate the “pneumatic splint” by endoscopic or other imaging or show that CPAP does not reflexly increase upper airway muscle activity.

Following the first description of CPAP use in obstructive sleep apnoea there was a period of several years before it was widely believed that this therapy was truly effective. One problem was the need to use silastic glue to fix the mask on the patient’s nose each night. Several groups developed different mask prototypes but the involvement of new technology companies led to more user friendly CPAP systems by 1986.

Comparison with other treatments

One of the great advantages of nasal CPAP is that it is immediately and demonstrably effective in relieving obstructive sleep apnoea. The other advantage is that it can be given on a “trial” basis and withdrawn if not tolerated, in contrast to surgical options. This is particularly important in milder cases of obstructive sleep apnoea or where the contribution of obstructive sleep apnoea to the patient’s symptomatology is unclear. Few studies have attempted to compare CPAP with other treatments for obstructive sleep apnoea using formal protocols. Virtually all of these studies have failed to randomise treatments. The effectiveness of nasal CPAP has been confirmed by a recent study from the UK that compared CPAP with an oral placebo in patients with a range of sleep apnoea and demonstrated improvements in MSLT scores and cognitive function, despite a mean CPAP use of less than four hours per night.

The first night of treatment

Sleeping with a nose mask and feeling the pressure sensation of CPAP, although not necessarily uncomfortable, are certainly novel
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Nasal airflow in a patient receiving continuous positive airway pressure (CPAP) treatment. The underlined breaths are “chopped off” — that is, they lack the normal rounded contour seen in the normal breath at the extreme right and are caused when subcritical levels of CPAP are used, resulting in residual partial upper airway obstruction.

daytime sleepiness on home treatment some physicians empirically increase CPAP pressure. Several factors may affect CPAP pressure. Weight gain may lead to a need for a higher CPAP setting.12 Heavy alcohol consumers pose other problems in CPAP usage. We frequently find that the critical CPAP pressure required is higher after large quantities of alcohol have been ingested, presumably because of the effect of alcohol in depressing the neuromuscular tone of the upper airways.13 However, this may not be a problem in moderate drinkers.19 One practical approach is to ask patients to drink their usual amounts of alcohol in the evening before a CPAP pressure determination is performed. Variable nasal obstruction may also lead to variable “correct” CPAP levels. This issue of varying CPAP requirements has led to interest in developing “intelligent” CPAP systems that vary the pressure according to the presence of upper airways limitation (see later).

Incorrect CPAP pressure setting may lead to compliance problems. In addition, in patients with severe sleep apnoea and marked depression of the arousal response to a variety of stimuli there may be a vulnerability to life threatening hypoxaemia in REM sleep.2 This phenomenon can occur in patients with carbon dioxide retention when a subcritical level of CPAP is selected, which results in partial upper airways obstruction during normally long “rebound” episodes of REM sleep. For this reason, such patients should always be treated for the first night under close supervision.

Can CPAP be commenced on the same night as sleep apnoea is diagnosed?

It has been suggested that CPAP can be initiated on the same night as the diagnosis is established.15 This would imply set laboratory policies on CPAP initiation and CPAP pre-treatment in all patients. The success of this procedure with abbreviated diagnostic and subsequent treatment determination has been questioned by Sanders et al.16 “These workers observed that, after such a “split night” study, most patients still required a subsequent change in CPAP pressure, mask, or switch to a BiPAP system. Although such split night studies may appear attractive from a short term economic point of view, incorrect treatment prescription may result in CPAP failure, more frequent outpatient visits with CPAP problems, and the need for further sleep studies negating short term financial advantages. The long term utility of “split night” studies is unproven as yet.

Can CPAP be commenced at home?

The economic advantages of starting CPAP at home and avoiding a formal polysomnographic CPAP pressure determination has been suggested by several groups.17 18 However, this has not been studied in any formal randomised protocol. In one case series from the USA17 patients without health insurance were given progressively increasing nightly CPAP settings at home with CPAP pressure and oxygen sat-
Adherence, Acceptance, Usage, Tolerance

The proportion of patients who meet selection criteria for CPAP treatment and actually proceed to have their CPAP pressure level determined. The proportion of patients who accept CPAP and commence home treatment. The proportion of patients prescribed CPAP who report that they are continuing to use CPAP without side effects. Often can be used interchangeably with "adherence." The proportion of patients who report that they are able to use CPAP machines "switched on" more than an arbitrary period of time. The proportion of patients using CPAP machines and delivering a pre-set level, i.e. the mask is likely to be on the patient's face.

Compliance and CPAP

How do these general issues in compliance impact on CPAP? In assessing the long term results of CPAP different words have been used including "acceptance", "tolerance", "adherence", "usage", "compliance", "efficacy" in descriptions of patient-CPAP interaction. To a large extent these terms describe different manifestations of a common concept, i.e. subjective terms used in early studies whereas more recent studies measure CPAP "usage" or "compliance" utilising time meters or more sophisticated devices that measure both run time and pressure delivery. True "efficacy" studies have yet to be performed as they would need to measure total sleep time over a set period and compare this with CPAP usage and the actual number of respiratory events not prevented by CPAP. For the purposes of this review, the terms used in relation to CPAP usage are listed in table 1. The criteria set for the terms may vary - for example, compliance for one group may be six hours of CPAP, six nights per week, while for others such criteria may be too strict.

Several specific factors affect CPAP compliance studies including machine cost, type of machine, the technical advances in masks, and prescriber motivation. In some countries machines are provided free of cost while in others cost may vary from US$1 to US$3000. Clearly this may lead to variable acceptance and prescription of the therapy. In addition, there have been rapid changes in CPAP technology. Current machines are quieter, with better masks

Table 1  Suggested terminology describing patient interaction with CPAP

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Acceptance</td>
<td>The proportion of patients who meet selection criteria for CPAP treatment</td>
</tr>
<tr>
<td>Prescription</td>
<td>and actually proceed to have their CPAP pressure level determined.</td>
</tr>
<tr>
<td>Adherence</td>
<td>The proportion of patients who accept CPAP and commence home treatment.</td>
</tr>
<tr>
<td>Tolerance</td>
<td>The proportion of patients prescribed CPAP who report that they are</td>
</tr>
<tr>
<td>Usage</td>
<td>The proportion of patients who report that they are able to use CPAP</td>
</tr>
<tr>
<td>Compliance</td>
<td>The proportion of patients using CPAP machines and delivering a pre-set</td>
</tr>
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</table>

It is important to recognise that at least 40–50% of patients do not use medication as prescribed. In general, compliance is not associated with age, sex, educational or economic status, or personality or characteristics of a disease including diagnosis or severity of frequency of symptoms. Others have reported

that physicians cannot predict better than chance only which of their patients will or will not be compliant. It appears, therefore, that compliance is not associated with any factor that might be used in everyday practice to make predictions about people's behaviour. Recently, Rand and colleagues found that, despite efforts to enhance compliance, over 70% of patients with chronic obstructive lung disease in a clinical trial did not comply with their prescribed drug treatment. Moreover, 15% of patients deliberately dumped their medications in order to appear to be following the physician's orders. It is reasonable to assume that more than half of patients on long term medication use their therapy differently from their doctor's prescription.

Several factors are associated with improved compliance including simplicity of regime, family support, the patient's perception that their disease is serious, belief that the proposed therapy will be effective, patient understanding of the rationale of treatment, provision of details of the treatment planned, and a close patient-clinician relationship including close clinician supervision of therapy. Interestingly, a review of six drug trials for various illnesses have shown that in five of them the compliant patients did significantly better irrespective of whether they were on active drug or placebo. Strategies for improvement of compliance include patient education, prescriber education, and simplifying treatment regimes.
Table 2 CPAP usage studies

<table>
<thead>
<tr>
<th>Author</th>
<th>Reference</th>
<th>Year</th>
<th>n</th>
<th>Type of study</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issa</td>
<td>29</td>
<td>1985</td>
<td>117</td>
<td>Questionnaire</td>
<td>92% adherence</td>
</tr>
<tr>
<td>Grunstein</td>
<td>30</td>
<td>1986</td>
<td></td>
<td>Questionnaire</td>
<td>57-80% adherence rate</td>
</tr>
<tr>
<td>Sanders</td>
<td>36</td>
<td>1986</td>
<td>24</td>
<td>Questionnaire</td>
<td>75% nightly adherence rate; 10 months follow up</td>
</tr>
<tr>
<td>Rolfe</td>
<td>37</td>
<td>1991</td>
<td>168</td>
<td>Questionnaire</td>
<td>64% adherence rate; maximal follow up 78 months</td>
</tr>
<tr>
<td>Höffstein</td>
<td>38</td>
<td>1991</td>
<td>96</td>
<td>Questionnaire</td>
<td>71-82% adherence rate after 17 (11) months</td>
</tr>
<tr>
<td>Krieger</td>
<td>39</td>
<td>1989</td>
<td>45</td>
<td>CPAP usage rate (&gt;3 hours/day); Follow up 8 months</td>
<td></td>
</tr>
<tr>
<td>Fletcher</td>
<td>40</td>
<td>1991</td>
<td>20</td>
<td>Meter readings (phoned in)</td>
<td>6-1 hours/day by reading meter</td>
</tr>
<tr>
<td>Kebbs</td>
<td>24</td>
<td>1993</td>
<td>35</td>
<td>Meter and mask pressure</td>
<td>46% CPAP success defined as compliance &gt;4 hours/day, 70% of days</td>
</tr>
<tr>
<td>Rauscher</td>
<td>35</td>
<td>1993</td>
<td>63</td>
<td>Meter readings</td>
<td>Mean use 4-9 hours/night</td>
</tr>
<tr>
<td>Reeves-Hoche</td>
<td>25</td>
<td>1994</td>
<td>47</td>
<td>Meter and mask pressure</td>
<td>In the 76% of patients adhering to CPAP, average compliance was 4-1 hours/night</td>
</tr>
<tr>
<td>Meurice</td>
<td>33</td>
<td>1994</td>
<td>44</td>
<td>Meter readings</td>
<td>68% users &gt;5 hours/night; 7 nights/week</td>
</tr>
<tr>
<td>Carlson</td>
<td>42</td>
<td>1994</td>
<td>40</td>
<td>Meter readings</td>
<td>50% regular users defined as machine-on time &gt;30 hours/week</td>
</tr>
</tbody>
</table>

and with a “ramp” facility to slowly increase the pressure over the first period of sleep. Most CPAP usage studies have employed superseded equipment and compliance data need to be continually updated to verify whether these technical changes do actually influence CPAP use or are purely cosmetic marketing ploys. This situation is analogous to clinical trials of new medications within the same drug class – for example, comparative studies of beta blockers.

Unlike the study of Rand and colleagues it appears that CPAP “dumping” is not a major factor. If a CPAP mask is taken off the face, then there is a detectable drop in pressure. If patients were simply switching on their machine and leaving the mask on the floor then there would be a major discrepancy between “machine on time” and “mask on face” time. This is not the case as simultaneous studies of CPAP use and pressure delivery at the mask reveal a high correlation between usage and compliance.

“Dosage” studies are not available for CPAP. Do patients have to use CPAP every night to receive beneficial therapeutic effects? Mean CPAP use of less than four hours per night produces demonstrable reduction in sleepiness. Another study showed that one night off CPAP in compliant CPAP users led to a recurrence in daytime sleepiness. A number of “biological” markers of CPAP usage may exist in all or certain patient subgroups.

However, these studies have not simultaneously measured the biological end point and objectively measured CPAP usage. At this stage all criteria for CPAP usage or non-use, or compliance or non-compliance, are essentially arbitrary.

Studies of CPAP usage

Early data from Sydney suggested that there was a high level of long term acceptance of CPAP. However, these patients had more severe forms of apnoea, were highly motivated by staff, and their subjective reports could not be corroborated by objective data. These early patients had to use a silastic sealant to glue a fibreglass mask onto their face. Interestingly, as the glue was provided by the sleep laboratory, glue usage provided a primitive form of objective measurement and it was clear at this early stage of CPAP development that “usage” was very variable.

In the section below, using the terminology (suggested) in table 1, available data on how patients interact with CPAP are discussed under separate headings.

HOW MANY PATIENTS WILL ACCEPT CPAP?

Few accurate data are available on this point as most studies only discuss patient data from the night of CPAP pressure determination or later. In one study 70% of patients offered a CPAP trial night accepted.

HOW MANY PATIENTS WILL AGREE TO PRESCRIPTION OF HOME CPAP?

The percentage of patients who refuse CPAP after an inhospital trial is variable. Two studies have reported prescription rates in excess of 80%, while other authors observed only a 58% prescription rate after an inhospital trial. There are many potential sources of prescription rate variability including machine cost which has a major impact in Australia, whether more than one night of an inhospital CPAP trial is possible, and the original selection criteria for CPAP. For example, we often first try certain patients with severe forms of sleep apnoea on CPAP supply on economic grounds, knowing that it is likely to be less effective and poorly tolerated compared with more expensive forms of therapy such as nasal ventilation.

HOW MANY PATIENTS WILL CONTINUE TO USE CPAP LONG TERM?

The data answering this question come from a range of subjective and objective studies, some of which are summarised in table 2. CPAP use at one month follow up can predict CPAP usage at three months follow up.

WHAT BASELINE INDICATORS INFLUENCE CPAP USAGE?

Data from the general compliance literature suggest that it is hard for physicians to predict good compliers at the time of initiation of therapy. This may be the case for medications but it may be a different situation for a mechanical treatment such as CPAP. In addition, CPAP provides immediate reinforcement of its efficacy in many patients with relief of daytime sleepiness. It is therefore possible that severity of symptoms has some role in maintaining
usage of CPAP. Several studies have confirmed the hypothesis that patients with good objective usage or reported adherence are sleepier at baseline,\textsuperscript{24} \textsuperscript{32} \textsuperscript{37} although other studies have not found this relationship.\textsuperscript{25} Although MSLT measured daytime sleepiness improves following CPAP,\textsuperscript{9} \textsuperscript{41} baseline MSLT scores do not appear to predict CPAP compliance.\textsuperscript{24} \textsuperscript{42} It is controversial whether the amount of improvement in MSLT scores will predict compliance in contrast to MSLT results at baseline.\textsuperscript{24} \textsuperscript{43} It is possible that in sleep apnoea the MWT (Multiple Wakefulness Test) may be a better predictor of CPAP use but this is untested. Other factors which may be related to a reduced usage include previous palatal surgery,\textsuperscript{32} absence of hypoxaemia,\textsuperscript{37} and fewer years of education.\textsuperscript{24} Surprisingly, in two larger series the CPAP pressure level was no higher in those having difficulties using CPAP.\textsuperscript{32} \textsuperscript{38}

**Table 3: Potential uses of “intelligent” CPAP devices**

<table>
<thead>
<tr>
<th>Potential uses of “intelligent” CPAP devices</th>
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<tbody>
<tr>
<td>(1) CPAP compliance diagnostics</td>
</tr>
<tr>
<td>(2) Easier CPAP pressure titrations</td>
</tr>
<tr>
<td>(3) Better CPAP compliance</td>
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</table>

**Summary**

In brief, the lowest CPAP usage rates have been reported in covert monitoring studies from the USA.\textsuperscript{24} \textsuperscript{26} Objective use rates from France certainly appear to be higher.\textsuperscript{33} \textsuperscript{39} This may reflect cultural differences or differences in study design. As mentioned above, without knowing actual sleep time even objective studies may still not provide accurate data on true effective compliance.

The impact of “intelligent CPAP”

The concept of intelligent CPAP involves the development of a device that can simultaneously detect apnoea and then generate a CPAP level that will prevent further apnoea. Advocates of the need for “intelligent” CPAP suggest that the pressure required for a patient may vary from night to night and thus the ideal CPAP machine should deliver a variable CPAP level adequate to prevent apnoea at the lowest possible pressure. Such a device may deliver a wide range of pressures on a single night depending on nasal obstruction, sleep stage, etc. These prototypes have been manufactured\textsuperscript{47} \textsuperscript{48} but the clinical usefulness of such devices is untested. A number of potential uses are listed in table 3.

**Side effects of CPAP**

**MINOR**

Most side effects related to CPAP use are minor and their major long term effect is discontinuation or reduced usage of CPAP. Common (approximately 30–50% of patients) side effects include inconvenience, poor mask fit, claustrophobia, and nasal problems.\textsuperscript{24} \textsuperscript{33} Inconvenience is a common complaint but is largely
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insurmountable, given the need for some form of mask and a pressure generating device. Mask fitting problems also require expert help and the wider variety of masks available will assist in reducing this as a problem. Claustrophobia can be reduced in some patients by use of a pressure “ramp”, slowing increasing pressure at onset of sleep or by gradual desensitisation or even with the use of a bi-level positive airway pressure device. However, some patients will remain completely intolerant.

Nasal side effects occur in 15–45% of patients. Most patients experience initial self-limiting congestion. In the long term, nasal mucosal drying which can be painful or chronic congestion are the main side effects. There appear to be several reasons for nasal symptoms. CPAP may provoke pressure sensitive mucosal receptors, leading to vasodilation and mucus production. In some patients it may unmask allergic rhinitis by restoring the nasal route of breathing after years of “mouth breathing”. In others, fixed nasal obstruction with polypos or a deviated septum may produce symptoms. Recently, studies of patients with mouth leak have revealed that the loss of nasally humidified air through the mouth will in turn lead to a disruption of the ability of the nasal mucosa to maintain humidification. Prevention of mouth leaks reduces rhinitis (G Richards, personal communication). There are few published data on the pathophysiology of nasal side effects of CPAP.

A multimodality treatment approach is required for nasal symptoms. Although an initial trial of an intranasal vasoconstrictor or intranasal steroids at bedtime may be helpful, in other patients with constant daytime nasal streaming an intranasal anticholinergic can be used on a short term basis. Patients with persistent symptoms of nasal congestion or those with obvious nasal obstruction should have nasopharyngoscopy performed and may require corrective surgery for an obstructive lesion such as polyps, may be mucosal thickening or a deviated septum. However, in our experience such nasal obstruction needs to be quite marked to be significant. Most patients in whom the ability to tolerate CPAP is affected by chronic nasal congestion benefit from attempts to reduce mouth leakage with chin straps or by adding a humidification system to their CPAP circuit. There are no objective data available on the effect of nasal decongestants or humidification on compliance rates.

Major

Despite the many thousands of patients currently using CPAP, major complications have rarely been reported. One case of massive epistaxis due to a drying effect of nasal CPAP has been observed. Nasal CPAP should not be used in patients with a history of either recent surgery or trauma that has caused a cerebrospinal leak. One report described the development of pneumocephalus after use of nasal CPAP in such a situation. Leakage of cerebrospinal fluid must be adequately corrected before nasal CPAP is recommenced.

Management of CPAP failure

What constitutes CPAP failure? This is a very subjective issue and practice will vary from centre to centre. A number of authorities have attempted to define CPAP failure. Kribbs et al defined CPAP failure as “the use of CPAP for less than four hours per night on 70% of the nights and/or lack of symptomatic improvement”. The specific figure of four hours was based on minimal criteria for adequate sleep from the general sleep literature on average sleep duration and the figure of 70% of nights was an arbitrary figure based on their group’s expert clinical opinion. Based on the objective part of this definition, 54% of 35 patients were CPAP failures. Clearly it is important to identify the cause of CPAP failure. Some of the commonest side effects and potential solutions are listed above. Claustrophobia is frequently a major cause of complete CPAP failure. Our practice is to run through a check list including looking for the possibility of secondary gain. Because of the nature of their illness, some patients with obstructive sleep apnoea are receiving or are potential recipients of some form of social welfare. A subgroup of these patients may not have the incentive to improve their fitness for work by use of the CPAP device to increase alertness. It is important also to consider if an incorrect diagnosis has been made. It is rare in the setting of comprehensive nocturnal respiratory monitoring or full polysomnography to make a false positive diagnosis of sleep-disordered breathing. However, it is more common to attribute patient symptoms to the degree of sleep-disordered breathing when there may be other co-existing disorders (recognised or unrecognised). An example of this may include patients with mild sleep apnoea and narcolepsy or idiopathic hypersomnolence where CPAP may be totally ineffective at abolishing sleepiness to any extent. Provided the physician recognises the potential causes of symptoms, a CPAP trial may be warranted and then CPAP failure may be approached as a diagnostic exercise. Many patients with sleep-disordered breathing CPAP may be inadequate to manage the respiratory disorder. For example, patients with obesity-hyperventilation syndrome may require nasal ventilation initially or, in some cases, long term. In other patients low flow oxygen needs to be administered in conjunction with CPAP.

Cases of CPAP failure are frequently admitted to hospital for a period of intensive inpatient training. The success of such treatment has not been investigated objectively. However, after exhausting all the relevant causes of CPAP failure in a patient with sleep apnoea who is completely intolerant of all varieties of nasal mask therapy (including bi-level positive airway pressure or nasal ventilation) despite intensive inpatient training, then the following issues need to be considered:

1. What is the potential risk of leaving the patient untreated?
2. How much does the patient want to be treated knowing the medical answer to question 1?
3. If the patient and physician agree on trying a different treatment, what should it be? This
would usually occur in patients where (i) co-existing sleepiness is seriously impairing daytime function; (ii) co-existing disease may be exacerbated by sleep apnoea with risk to the patient (this risk may at times be a potential risk due to a lack of hard data in the medical literature); (iii) there is evidence of severe hypoxaemia or awake cardiorespiratory failure even without sleepiness.

**Treatment options for patients with CPAP failure**

**SURGERY**

Although strong claims are made for maxillofacial surgery, published experience is predominantly from one group with particular expertise. Therefore, at this stage such surgery must be considered experimental, particularly until long term follow up is available from a number of groups. Uvulopalatopharyngoplasty (UPPP) has no place or only a very limited role in CPAP failure, particularly in categories (i), (ii) and (iii) above. This view is based on the increasing literature demonstrating the limited efficacy and risks of UPPP for patients in these categories. “Minimalist” tracheostomy is an effective option for CPAP failure despite the potential complications and effects on lifestyle. This is not a simple decision to make and detailed patient evaluation and re-study should be performed before tracheostomy.

**OTHER ALTERNATIVES**

Oral appliances which reposition the mandible and maxilla or tongue have been suggested treatments for obstructive sleep apnoea. These may be potentially useful in patients with CPAP failure but documentation is limited at this stage. One problem is that the long term effects of such devices on temporomandibular joint dysfunction is not known. Oxygen therapy has been used in obstructive sleep apnoea with mixed results, but its role may be limited to CPAP failures with marked hypoxaemia who have a demonstrated reduction in hypoxaemic events on oxygen therapy. Transtracheal oxygen has recently been used in obstructive sleep apnoea but experience is limited.

**Summary**

CPAP should be considered the first line of treatment in patients with moderate to severe obstructive sleep apnoea. In our centre in Sydney this generally means patients with more than 20 apnoea/hypopnoeas per hour with repeated dips in oxyhaemoglobin saturation and usually some symptomatology. Despite this first line role of nasal CPAP, recent objective studies question whether earlier enthusiastic reports on adherence to CPAP are correct. The role of technical innovations in new CPAP machines in improving usage remains to be tested. The “drop out” rate from physician selection for a CPAP trial to highly compliant user is certainly more than 50% of patients. What happens to these patients? Data from some studies suggest that surgical treatments are used, at least in the USA, but in all probability many of these patients remain untreated. The challenge in the next decade is either to improve CPAP devices to increase usage in this group or to develop other treatment options. The role of intensive inhospital “acclimatisation” to CPAP also has yet to be objectively tested.

It is unclear whether “intelligent” CPAP will make huge inroads in increasing the number of patients who accept CPAP trials, prescriptions, or compliance. It will have minimal impact on patients with mask problems or claustrophobia or those who feel that CPAP is inconvenient. There is a high likelihood that it will reduce technologist workload during CPAP titration studies. “Intelligent” CPAP may help to reduce total overnight mouth leakage and therefore reduce nasal side effects. The current expense of developing such devices will mean that they are unlikely to supersede much cheaper standard “one pressure” CPAP machines in the next few years.

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