

# Adult chronic sleepwalking and its treatment based on polysomnography

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## Summary

Adult sleepwalking affects 2.5% of the general population and may lead to serious injuries. Fifty young adults with chronic sleepwalking were studied prospectively. Clinical evaluation, questionnaires from patients and bed partners, and polysomnography were obtained on all subjects in comparison with 50 age-matched controls. Subjects were examined for the presence of psychiatric anxiety, depression and any other associated sleep disorder. Isolated sleepwalking or sleepwalking with psychiatric disorders was treated with medication. All other patients with other sleep disorders were treated only for their associated problem. Prospective follow-up lasted 12 months after establishment of the most appropriate treatment. Patients with only sleepwalking, treated with

benzodiazepines, dropped out of follow-up testing and reported persistence of sleepwalking, as did patients with psychiatric-related treatment. Chronic sleepwalkers frequently presented with sleep-disordered breathing (SDB). All these patients were treated only for their SDB, using nasal continuous positive airway pressure (CPAP). All nasal CPAP-compliant patients had control of sleepwalking at all stages of follow-up. Non-compliant nasal CPAP patients had persistence of sleepwalking. They were offered surgical treatment for SDB. Those successfully treated with surgery also had complete resolution of sleepwalking. Successful treatment of SDB, which is frequently associated with chronic sleepwalking, controlled the syndrome in young adults.

**Keywords:** sleepwalking; sleep-disordered breathing; adult; treatment; polysomnogram

**Abbreviations:** CPAP = continuous positive airway pressure; OSAS = obstructive sleep apnoea syndrome; Pes = oesophageal pressure; PLMD = periodic limb movement disorder; PSG = polysomnography; RLS = restless leg syndrome; SDB = sleep-disordered breathing; SSRI = serotonin-selective reuptake inhibitor; UARS = upper airway resistance syndrome

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## Introduction

Somnambulism is an arousal parasomnia consisting of a series of complex behaviours that result in walking during sleep (Broughton, 1968). It commonly occurs during the first third of the night, when slow-wave sleep is predominant. The individual is in an EEG state of incomplete awakening during the episode (Jacobson *et al.*, 1965; Schenck *et al.*, 1989, 1998). Its prevalence is 2–14% in children (Klackenberg, 1971, 1982; Kales *et al.*, 1980; Liu *et al.*, 2000; Neveus *et al.*, 2001) and it is often outgrown when onset is before 10 years of age (Kales *et al.*, 1980). However, up to 25% will continue to sleepwalk in adulthood (Hublin *et al.*, 1997). Prevalence in adults is 1.6–2.4% (Ohayon *et al.*, 1999). Sleepwalking affects 2.5% of the general adult population of the

UK (Ohayon *et al.*, 1999). It is associated with risks of trauma, violence and uncontrolled behaviour that may be life-threatening (Moldofsky *et al.*, 1995). Despite the frequency of the problem, the underlying factors associated with the confusional arousals are mostly unknown. Few studies have been published regarding treatment of sleepwalking. When sleepwalking was associated with sleep terrors and possibly related to identifiable psychic trauma (e.g. sexual abuse, rape and severe physical aggression), pharmacotherapy and psychotherapy (Remulla and Guilleminault, 2005) have been the treatment approaches used in adult chronic sleepwalking. Pharmacotherapy for somnambulism consisted of benzodiazepines [diazepam, clonazepam (Goldbloom and

Chouinard, 1984; Schenck *et al.*, 1989; Schenck and Mahowald, 1996), triazolam (Berlin and Qayyum, 1986), flurazepam (Mendelson, 2000), tricyclic antidepressants [e.g. imipramine in adults with sleep terrors and sleepwalking (Marshall, 1975; Cooper, 1987; Garland and Smithe, 1991)] and serotonin-selective reuptake inhibitors (SSRIs) [paroxetine (Lillywhite, 1994)]. But the pharmacological treatment of sleepwalking remains largely anecdotal (Remulla and Guilleminault, 2004).

For the past 25 years, all adult sleepwalkers referred to the sleep clinic due to the chronicity of their behaviour, disturbance to their environment and trauma risks to themselves or others have been submitted to the same diagnostic protocol evaluation, with sleep-deprived clinical EEG awake and asleep, urine drug screen, and nocturnal polysomnography (PSG). Rarely, the chronic abnormal behaviour was related to a seizure disorder. In over 97% of the cases, the chronic behaviour was classified as sleepwalking (parasomnia). Over the years, we began to appreciate the frequency with which other sleep disorders were also shown in the PSGs, and we began treating the associated sleep disorder as the first therapeutic approach. As part of an overall evaluation of procedures and protocols, we performed a 4-year retrospective analysis of clinical and polysomnographic findings and response to treatment of adult individuals who had at least two follow-ups with one at least a year after initial evaluation. One hundred and one subjects (mean age  $25.2 \pm 5$  years; 33 women) were identified in the database. Initiation of treatment and scheduled follow-up were determined based on the

results of the initial evaluation and PSG. Fifty-seven subjects had had EEG, including 11 with long-term EEG monitoring. MRI had been performed in 18. However, none had a PSG as a first test. Prior treatment had involved psychotherapy, benzodiazepines, carbamazepine, valproic acid and imipramine. None of these drugs provided complete control of the sleep-related behaviour. Evaluation and PSG indicated that 99 out of 101 patients had either obstructive sleep apnoea syndrome (OSAS) or upper airway resistance syndrome (UARS). All patients were unaware of their sleep-disordered breathing (SDB), and none complained of daytime sleepiness.

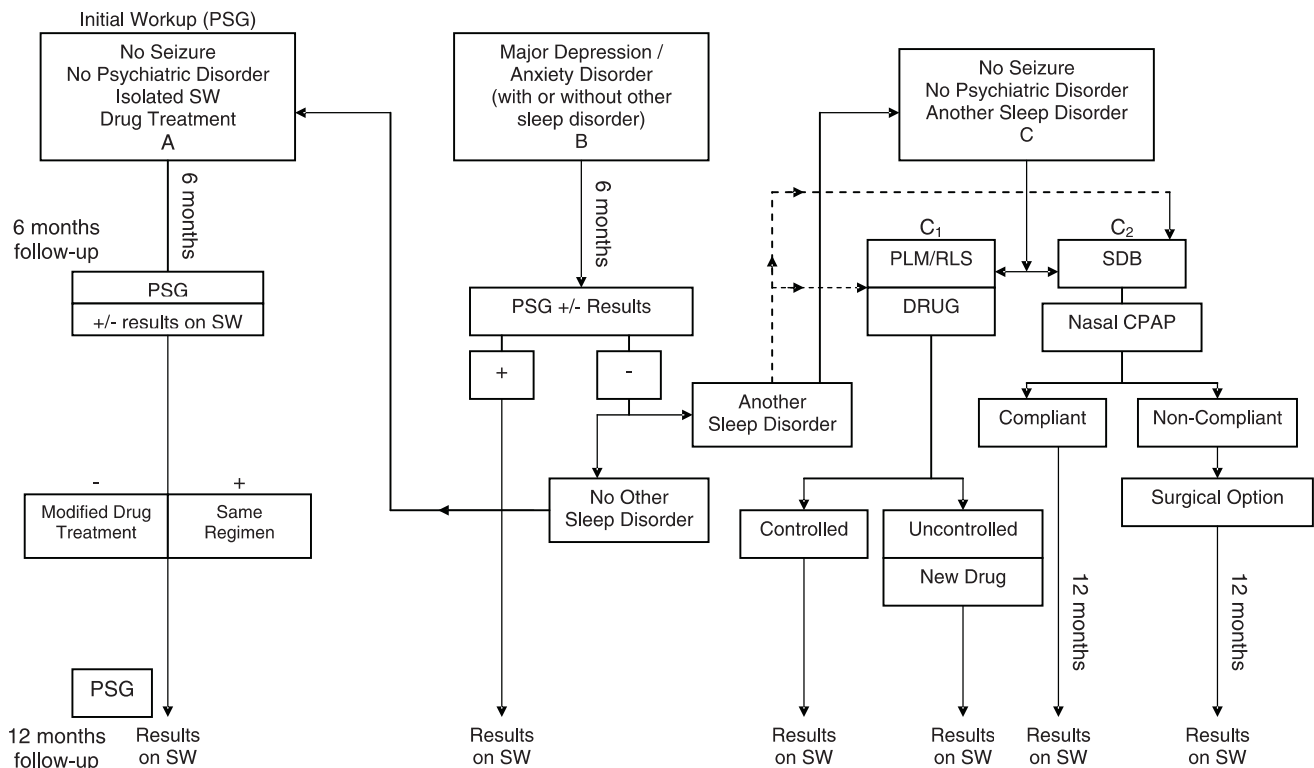
Based on this retrospective data, a clinical prospective investigation was planned.

**Methods**

**Prospective clinical protocol**

Based on results of the investigation, a treatment strategy was built and its application was planned as follows (Fig. 1).

- (1) Patients presenting with a history of important psychological trauma/psychiatric disorder would be referred to a psychiatrist as the treatment of first intention. A re-evaluation would be made 6 months after the start of treatment. If no response to treatment implemented by the specialist was observed after this period of 6 months, subjects would be considered for the prospective protocol.
- (2) All other patients with an associated sleep disorder [restless leg syndrome (RLS)/periodic limb movement disorder (PLMD)/OSAS/UARS/] would be treated for the associated syndrome as the treatment of first intention. No other treatment would be



**Fig. 1** Schema of treatment in chronic sleepwalkers.

applied, as no specific treatment is currently recommended for chronic sleepwalking. Pharmacological treatments prescribed to date have had failure- and drug-related side-effects. All patients would receive nasal CPAP for SDB; the device prescribed was able to determine hourly usage of the equipment, with a measure of mask pressure. For RLS/PLMD, the initial treatment would be pramipexol administered at the time of the evening meal.

- (3) A complete reassessment would be performed 6 months after the initiation of treatment.
- (4) CPAP subjects non-compliant at 6 months would be offered the option of surgical treatment for their SDB.
- (5) A complete re-evaluation would be performed 12 months after the initial treatment for subjects compliant with treatment. For subjects deciding to undergo surgery, a complete re-evaluation would be performed 12 months after the last surgical treatment.
- (6) An age- and gender-related control group would be recruited and submitted to the same interview and recording.
- (7) At the conclusion of 12 months of study evaluation, all polysomnographic records would be copied onto CD-ROM, without indication of date and diagnosis. They would then be rescored by one individual who was blind to the condition of the subject (namely, treated versus untreated patient, control).
- (8) Final evaluation of the response to treatment would be performed after all PSGs had been blindly scored and all data had been placed on a computerized database.
- (9) As we used an intention-to-treat protocol, all data obtained at entry would be placed in the analysis. If a subject decided to consider a different treatment or stop any treatment for any reason, great effort would be made to see the patient before treatment interruption. PSG would be obtained, independently of the duration of treatment, before interruption, with patient agreement.
- (10) Any dropout would be replaced, so that 50 subjects would be followed up at 12 months. Information on the number of chronic adult sleepwalkers seen during the period of time of prospective study would be kept.
- (11) If no other sleep disorder was recognized after initial evaluation, patients would be told about the absence of a firm treatment recommendation for their syndrome. They would be offered a medication trial (i.e. clonazepam 0.5–2 mg at bedtime) and recommendations regarding sleep hygiene and stress management. If subjects had no response to treatment or if no side-effects (particularly daytime sleepiness) were noted, trials with temazepam, carbamazepine or gabapentin at bedtime would be done. If this next step failed to evoke a response, the treating specialist could try another pharmacological agent mentioned in the literature.
- (12) Independently of treatment, all subjects would receive sleep hygiene instruction. In particular, patients were advised to maintain a regular sleep schedule, avoid alcohol, and follow safety recommendations. They were instructed to remove potentially dangerous objects from the room (e.g. mirrors); to clear the floor of obstructions; to place heavy drapes (curtains) on windows; to lock doors and windows; and to sleep on the ground floor (Schenck and Mahowald, 1996). Patients were asked to place their mattress directly on the floor and, possibly, to use a sleeping bag.

## Procedure

### Initial evaluation

All sleepwalkers had clinical interviews, review of medical history and systems, and sleep/wake evaluations. They filled in the Sleep

Disorders Questionnaire (Douglass *et al.*, 1994) and Epworth Sleepiness Scale (Johns, 1991). A systematic otolaryngological–maxillo-mandibular evaluation with the use of standardized scales (Mallampati *et al.*, 1985; Friedman *et al.*, 1999) was obtained. An interview with available bed partners was performed. If no bed partner was available, a household member or an individual having witnessed sleepwalking was interviewed. A questionnaire was sent to a living family member regarding childhood presentation of abnormal nocturnal behaviour and treatment trials. All subjects had a sleep-deprived clinical EEG awake and asleep, urine drug screen, and nocturnal PSG. This test always encompassed monitoring of EEG (C4/A1, C3/A2, Fp1/T3, T3/O1, Fp2/T4, T4/O2, Fp1/C3, Fp2/C4), electro-oculogram, chin and leg EMG, ECG (modified V2 lead), body-position sensor and monitoring of respiration. Specifically, there was investigation of air flow with nasal cannula–pressure transducer and mouth thermistor, thoracic and abdominal bands, oesophageal pressure (Pes), neck microphone and finger pulse oximetry. Subjects were videotaped during PSG.

Patients were sent for psychiatric evaluation and were divided into two subgroups. If pathological depressive reaction and/or anxiety disorder was diagnosed, the patient was treated by pharmacological means and/or psychotherapy under the care of the psychiatrist for 6 months. If no recommendation for psychiatric treatment was made, subjects without another PSG-identified sleep disorder were told about the uncertainty concerning pharmacological treatment, and the approaches outlined in the protocol were followed. Subjects with another sleep disorder were made aware of the presence of the other pathology and advised to first treat the other sleep disorder, where treatment is well codified. If SDB was recognized, a nasal CPAP titration night was scheduled.

### Control subjects

Fifty subjects were recruited. They had had a telephone interview to check for absence of sleep disorder history, current shift work, chronic illness and drug intake. Overweight subjects were also eliminated, as sleepwalkers in the retrospective study were non-obese. Subjects underwent clinical evaluation, filled in the same questionnaires as patients and underwent two nights of polysomnography (one with and one without Pes).

### Follow-up (Fig. 2)

All sleepwalkers not referred to psychiatrists were scheduled for clinical follow-up at 4 weeks and 3 months. All visits included a short log indicating frequency of sleepwalking, an interview with bed partner or family member and downloading of compliance information from nasal CPAP equipment when prescribed. At 6 months, in agreement with the treating psychiatrist, all sleepwalkers were also seen again. The visit at 6 months included the log of sleepwalking frequency, completion of the same questionnaires as at entry, re-evaluation of subjects, down-loading of CPAP compliance data, and a new PSG.

Following this re-evaluation, several options were available based on the findings.

- (A) The patient was monitored for sleepwalking, the current treatment was pursued and follow-up visits at 9 and 12 months were scheduled.
- (B) The patient was not monitored for sleepwalking.

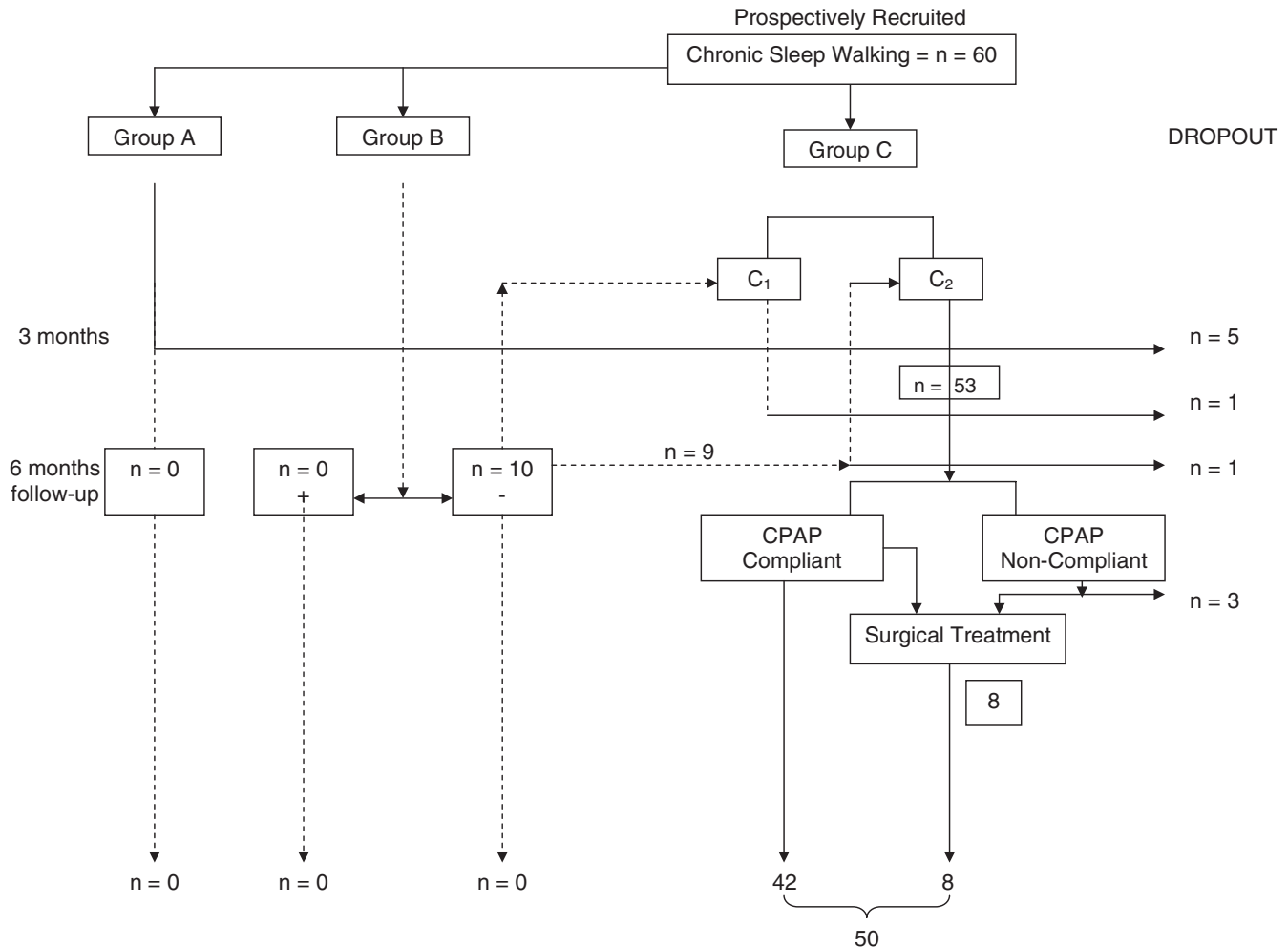


Fig. 2 Treatment of prospective group.

- (1) The patient was in the 'psychiatric treatment group'.
  - (a) The patient presented with another sleep disorder and was offered treatment for this other sleep disorder; follow-up was scheduled.
  - (b) The patient had no other sleep disorder; a drug treatment, as mentioned in the literature, was offered.
- (2) The patient had received nasal CPAP as treatment for SDB and was non-compliant. The patient was seen by a surgeon specializing in sleep-related surgery; surgical options were discussed. If surgery was performed, patients had regular follow-up for sleepwalking and evaluation of treatment on SDB 4 weeks and 3, 6, 9 and 12 months after surgical treatment.
- (3) The patient had no other sleep disorder, had been prescribed one or several drugs, and had been compliant with drug intake and follow-up schedule. The patient had a visit at 9 months and re-evaluation at 12 months.

All subjects had a 12-month re-evaluation that involved the same tests and procedures as the initial evaluation, with clinical review, questionnaires, bed partner/family member interview and PSG.

### Data analysis

As mentioned, PSGs were scored for clinical purposes by technicians during the follow-up period. The PSGs of all controls and patients were rescored by one individual blind to condition for the purpose of this study. PSGs were scored using international criteria (Rechtschaffen and Kales, 1968; American Sleep Disorders Association, 1992; American Academy of Sleep Medicine, 1999). Sleep was tabulated for sleep stages (Rechtschaffen and Kales, 1968), but short EEG arousals (duration between 3 and 15 s) were also scored (American Sleep Disorders Association, 1992). For scoring of SDB, hypopnoeas were defined as 30% reduction in nasal airflow compared with prior normal breathing for at least 10 s. Apnoeas were defined as decreased nasal flow of at least 70% for at least 10 s. A drop of oxygen saturation ( $\text{SaO}_2$ ) > 3% or an EEG arousal was required to score these events (American Academy of Sleep Medicine, 1999). An apnoea-hypopnoea index (AHI) (number of apnoeas and hypopnoeas per hour of sleep) was calculated. A second scoring was performed using measurements obtained from nasal cannula, pressure transducer and oesophageal pressure. These measures enabled scoring of flow limitation (change in flow of >3 and <30%) and detection of increased respiratory efforts. The latter was indicated by change in peak

end-inspiratory Pes curve (Guilleminault *et al.*, 1995, 2001) with presence of Pes crescendos, presence of 'continuous sustained effort' and presence of Pes reversal (Guilleminault *et al.*, 1995, 2001; Black *et al.*, 2000). These respiratory changes were not required to end with a visually scored EEG arousal, but respiratory events related to arousal (American Academy of Sleep Medicine, 1999) were also tabulated, and a respiratory disturbance index (RDI) was calculated. Patients who had the above polygraphic patterns but did not have apnoeas were diagnosed with the upper airway resistance syndrome (UARS) (Guilleminault *et al.*, 1993). A diagnosis of UARS was always based on AHI <5, absence of sleep apnoea, oxygen saturation >92%, presence of flow limitation (<30% flow) at the nasal cannula, and presence of increased respiratory efforts, as indicated by the Pes curve (Guilleminault *et al.*, 1995, 2001; Black *et al.*, 2000). Termination of flow limitation was indicated either by respiratory events related to arousal (American Academy of Sleep Medicine, 1999) or with Pes reversal (Guilleminault *et al.*, 1995, 2001) without alpha EEG arousal. Periodic limb movements were scored according to the American Sleep Disorders Association Atlas criteria (1992).

### Statistical analysis

Kruskal–Wallis analysis of variance, the Mann–Whitney *U* test or the paired *t* test was used, based on the normality of distribution, for statistical comparison between groups.

### Results

A total of 60 sleepwalkers (18 women) were seen, and 50 of them had a complete follow-up 12 months after the end of treatment. Their mean age was  $24.1 \pm 6$  years (range 18–42 years) (Fig. 2).

### Dropouts

There were 10 subjects who did not have a follow-up at 12 months. They include five subjects with no other sleep disorder at PSG. Three other patients had been recognized with sleepwalking and mild OSAS ( $n = 2$ ) or UARS ( $n = 1$ ); they did not like nasal CPAP treatment, had been non-compliant with treatment, and did not like the surgical alternative. Two patients had been sent to a psychiatrist for treatment of major depression ( $n = 1$ ) and anxiety disorder ( $n = 1$ ). Both patients had stopped regular psychiatric visits and treatment within 2 and 4 months, with reported absence of change in sleepwalking frequency. These two patients also had PLMD ( $n = 1$ ) and UARS ( $n = 1$ ) but refused any further treatment.

### Final prospective group

Fifty subjects (mean age  $24.7 \pm 5.2$  years; 15 women), who were chronic sleepwalkers (mean  $18.7 \pm 9.5$  years of sleepwalking history), had follow-up 12 months after the start of recommended treatment and had been compliant with it. These subjects had previously sought treatment because the abnormal behaviour had been either a social embarrassment in this young adult group or a source of concern; 15 had injured themselves or others during at least one event.

The 50 normal controls (16 women) had a mean age  $25.6 \pm 5.7$  years. There was no age difference between controls,

patients who dropped out, or sleepwalkers who ended the prospective study (Kruskal–Wallis ANOVA).

### Sleepwalkers

#### Results of initial investigation

The 50 subjects who ended the study were free of any medication for at least 2 months when studied at baseline. Many had received medications without improvement of their sleepwalking (Table 1) and had past medical histories associated with SDB (Table 1). Despite their sleepwalking, most of these subjects were in overall good health, with a mean body mass index (BMI) of  $23.1 \pm 1.1$  kg/m<sup>2</sup> (range 19–24.3). Eleven subjects were known to be loud snorers. Twenty-eight were noted to snore intermittently or were mouth-breathers, but snoring was not a social issue. Following psychiatric evaluation, eight of the 50 subjects who terminated the study were felt to have depression ( $n = 5$ ) or major anxiety disorders ( $n = 3$ ) at entry. Five received medications [including SSRIs ( $n = 3$ ), anxiolytics ( $n = 2$ ) or trazodone HCl ( $n = 1$ )] and psychotherapy; four were treated with psychotherapy and stress management.

PSG results for the 50 subjects are presented in Table 2. Independently of psychiatric diagnosis, all subjects presented with SDB, even if with low AHI scores. ESS scores were not supportive of daytime sleepiness (mean  $6.3 \pm 1.5$ , range 4–10); only two subjects scored 10. However, 36 subjects reported the presence of 'fatigue' without somnolence.

### Control group

The mean BMI was  $23.4 \pm 1.8$  (range 20–24.8) kg/m<sup>2</sup> (non-significant, as compared to sleepwalkers). Eight subjects had a history of tonsillectomy and adenoidectomy in childhood,

**Table 1** Prior drug trials and relevant past medical history: final prospective group (50)

	<i>n</i>	%
Prior drug intake		
Zolpidem	36	72
Clonazepam	7	14
Lorazepam	5	10
SSRI	19	38
Trazodone	26	52
Carbamazepine	2	4
Valproic acid	3	6
Psychotherapy/counselling	11	22
Prior health problems		
Repetitive childhood otitis/URI	21	42
Bruxism	19	38
Wisdom tooth extraction due to impaction/ orthodontics with tooth extraction	30	60
Asthma	4	8
Upper airway allergies	29	58
Tonsillectomy/adenoidectomy	20	40
Enuresis (>7 years old)	7	14
Psychological childhood trauma	9	18

**Table 2** Respiratory findings during sleep: final prospective group

	n (%)
AHI >5	12 (24)
AHI <5	38 (76)
Mean AHI $\pm$ SD	8 $\pm$ 11 (range 1–23)
Mean RDI	17 (range 6–37)

n = number of subjects; RDI = respiratory disturbance index.

but there was no positive orthodontic history. According to the recruitment definition, all were in general good health and were not taking medication. The mean AHI for the group was  $0.8 \pm 0.7$  events/hour ( $P = 0.0001$ ) and the mean RDI was  $1 \pm 0.4$  ( $P = 0.0001$ ).

### Follow-up at 4 weeks

The patients equipped with nasal CPAP were seen at the 4-week follow-up. If needed, headgear and masks were adjusted and humidification was added. Downloading usage of CPAP showed limited usage (<3 h/night in the first eight patients studied).

### Follow-up at 3 months

Logs and reports by bed partners or family members showed persistence of sleepwalking. There was no significant change compared with baseline in subjects who had a mean of less than 2 h of nasal CPAP usage per night and absence of sleepwalking for the past month in subjects with good compliance (>5 h/night). Downloading compliance data showed the absence of usage of nasal CPAP in half of the non-compliant subjects for the last month and very intermittent usage for the other half; there was usually some usage after a sleepwalking event.

### Follow-up at 6 months

#### *Sleepwalker with absence of other sleep disorder or psychiatric disorder*

As mentioned, all sleepwalkers treated by medication alone dropped out from the follow-up study and PSG recordings. These subjects were placed on clonazepam, but four out of five subjects had limited results at 3 months follow-up. They reported a decrease in sleepwalking events under particularly high daytime stress at 6 months but did not want to undergo further PSGs at 12 months. The last patient had a similar report at this 6-month follow-up but requested to be followed by a family practitioner closer to home.

#### *Non-compliant SDB without psychiatric disorders drop-out*

Three patients non-compliant with nasal CPAP as mentioned did not want any further follow-up or surgery. No drug trial completely eliminated their problem. Telephone contact with these patients at 12 months indicated persistence of the problem, some decrease in the frequency of sleepwalking, and

usage of clonazepam ( $n = 2$ ) and temazepam ( $n = 1$ ) as prescribed by the family physician.

### *Sleepwalkers with initial psychiatric treatment*

None of the 10 subjects had control of their sleepwalking events. The two who dropped out also had PLMD ( $n = 1$ ) and UARS ( $n = 1$ ). The 50 sleepwalkers who were reassessed following the protocol included eight subjects with psychiatric treatment and 42 subjects with SDB as an associated sleep disorder (OSAS or UARS). Clinical evaluation was unchanged; mean ESS was  $5.8 \pm 1.6$  [as from baseline (range 4–9)]. Logs of sleepwalking events showed 33 individuals without sleepwalking for over 3 months, and 17 subjects with sleepwalking. Comparing the number of events at entry and last month, these 17 sleepwalkers showed no significant change. Bed partners or family members confirmed positive and negative results. The 17 negative results were seen in patients treated by psychiatrists with drugs and psychotherapy ( $n = 8$ ) and nine subjects treated with nasal CPAP. There was a significant difference when the number of hours of nasal CPAP used during the last month was compared between positive and negative reports of sleepwalking ( $P = 0.0001$ ). The usage of nasal CPAP was nil in five patients; there was a mean of 1.6 h per night in the four other patients who had persistence of sleepwalking, compared with a mean of 6.1 h for the 33 compliant patients who had complete absence of sleepwalking.

In summary, patients with only sleepwalking treated with the usual medication for sleepwalking had dropped out, citing limited control of their problem. Patients followed by a psychiatrist and treated with drugs and/or psychotherapy had persistence of sleepwalking events, as did patients who were non-compliant with nasal CPAP treatment.

### *Follow-up subsequent to the first 6 months*

The compliant subjects continued nasal CPAP and were seen again at 9 months for clinical visit and 12 months for full reassessment.

Subjects treated by a psychiatrist with persistence of sleepwalking but who also had another sleep disorder and who agreed to try new treatment were offered enrolment in the full treatment protocol. These subjects underwent the 12-month protocol as planned with regular follow-up at 4 weeks and 3, 6, 9 and 12 months. Medication provided by the psychiatrist was initially maintained. Four subjects were able to discontinue these medications progressively with supervision by their psychiatrist; they were all free of drugs between follow-up months 6 and 12. Two subjects continued usage of low doses of SSRIs until the end of the study; one subject in this group selected a surgical option during the treatment follow-up.

Non-compliant subjects with nasal CPAP during the first 6 months were offered surgical treatment of their SDB, as proposed to all non-compliant SDB patients in our clinic.

Patients underwent the clinical surgical work-up performed by the appropriate specialists. Based on clinical, radiological and endoscopic evaluations, they were offered specific surgical approaches. As mentioned above, two patients refused any further treatment and were considered dropouts from the prospective protocol; they were replaced by two new subjects. Eight CPAP non-compliant subjects with SDB and sleepwalking accepted surgical treatment. Four subjects were treated by uvulo-flap with radiofrequency of inferior nasal turbinates; the remaining four subjects underwent tonsillectomy with lateral wound pharyngeal suturing, adenoidectomy and distraction osteogenesis (Guilleminault and Li, 2004) involving the upper and lower jaws, leading to lateral widening.

### ***Follow-up at 12 months after final treatment***

All subjects with nasal CPAP treatment ( $n = 42$ ) showed a compliance of  $5.8 \pm 0.5$  h/night.

PSGs indicated a mean AHI of  $0.2 \pm 0.2$  events/h. Sleep logs and bed partner or family member reports showed an absence of sleepwalking for the last 6 months. The mean AHI for the eight surgical subjects was  $2 \pm 1.8$  events/h; all subjects and bed partners or family members also reported complete absence of sleepwalking for the last 6 months prior to re-evaluation.

### **Discussion**

Chronic sleepwalking in young adults can be life-threatening. Although injuries to self or others were reported by 30% of our subjects, treatment of sleepwalking is poorly codified. Our retrospective study is notable for the frequency of another sleep disorder present in sleepwalkers. SDB was frequent. However, the well-known OSAS was not present to the degree that UARS was. Poorly recognized, UARS is often missed at PSG, particularly without appropriate sensors. We planned a clinical study applying the approved standard of care. All subjects with isolated sleepwalking were prescribed the most commonly used medication for sleepwalking. Despite a reported decrease in the frequency of events, no patients had complete control of their syndrome. This was associated with dropout from the demanding long-term follow-up schedule. All patients who dropped out were called 12 months after initiation of medication; they indicated a persistence of events. Psychiatric conditions have been associated with the presence of sleepwalking. All patients were seen by a psychiatrist and were referred for specialized treatment if a psychiatric syndrome was identified. But at 6 months, systematic follow-up, including PSG, shows that all subjects had persistence of sleepwalking events. Subjects who had been found to have another sleep disorder but no psychiatric condition were first offered treatment for this disorder, in which treatment is better codified. We offered the same approach to subjects who had been sent to a psychiatrist but failed to demonstrate a complete response during the first 6 months of psychiatric treatment. Not every patient

agreed to our recommendations, presumably because the other sleep disorder was discovered by systematic evaluation and was neither a primary complaint nor the cause for their referral. All patients who continued drug treatment had persistence of sleepwalking events, though they all reported a decrease in the frequency of events. Patients with SDB were all treated with nasal CPAP; we did not perform a double-blind active versus sham CPAP study. Instead, all patients had equipment that automatically measured the total number of hours of nasal CPAP usage; compliance was based on the measurement of mask pressure. Also, patients were aware that the goal was the treatment of the other sleep disorder. Non-compliance with nasal CPAP, a known problem with this treatment, was noted. There was a correlation between usage of nasal CPAP and complete absence of sleepwalking, as reported both by subjects and also by bed partners at the 6-month follow-up. But sleepwalking was still present in non-compliant subjects. As customary in our clinic, non-compliant subjects were offered an evaluation by a surgical team specializing in treatment of SDB. After this evaluation, some non-compliant patients decided not to pursue a further surgical option; these individuals did not become more compliant with nasal CPAP. In fact, they felt that their primary concern had not been addressed and consequently dropped out of the follow-up. Despite our concern about the prescription of clonazepam in patients with SDB, follow-up phone calls at 12 months demonstrated that they had had medication treatment and that sleepwalking still occurred. No further information was available.

All subjects who accepted surgical treatment for their SDB had good control of their breathing disorder. A complete re-evaluation 12 months after the last surgical treatment showed a very low AHI in all cases. Subjects and bed partners also reported a complete absence of sleepwalking events for at least the past 6 months. This prospective study systematically evaluated the presence of another sleep disorder and its treatment; thus, it confirms the finding of the retrospective study and findings in prepubertal children (Guilleminault *et al.*, 2003). Some questions remain unanswered. For example, our compliant subjects had a mean usage of nasal CPAP above 5 h per night, while our non-compliant subjects used their nasal CPAP for less than 90 min. We do not know the amount of compliance which is needed to control sleepwalking.

It was disappointing to find that subjects with no other identifiable sleep disorder were unable to completely control their sleepwalking with appropriate medication. We must acknowledge that we did not try all drugs mentioned to help chronic sleepwalking. Instead, we used the most prescribed medication, i.e. benzodiazepines. However, gabapentin and carbamazepine have also been tried. Finally SDB, particularly UARS, was found to have a common association with chronic sleepwalking in young adults. In their general population survey, Ohayon *et al.* (1999) found that OSAS was the most common sleep disorder associated with sleepwalking in subjects aged 15–24 years. Espa

*et al.* (2002) investigated 10 sleepwalkers and found that SDB may be associated with sleepwalking in some of their subjects. Guilleminault *et al.* (2002) investigated sexual violence during confusional arousal. Three of their subjects had sleepwalking and associated SDB. Once their SDB was treated, their sleepwalking was eliminated. Our study is unable to address the question of why patients with another sleep disorder develop or become more susceptible to sleepwalking. Even if an association between another sleep disorder, particularly SDB, is seen in a general population survey, not all cases of OSAS and UARS present with sleepwalking. As shown here, we were unable to detect another sleep disorder in a small group of sleepwalkers. Our hypothesis is that the other sleep disorder is responsible for an increase in sleep disruption and favours confusional arousal. Depending on other factors (e.g. stress, personality trait, mood stability), the confusional arousal leads to sleepwalking. Once the sleep disorder which causes the sleep disruption is treated, the background on which sleepwalking will occur is eliminated. Because current medical treatments are associated with only a partial response, it is valid to search for another sleep disorder in young adults who present with chronic sleepwalking.

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