Portable Computerized Polysomnography in Attended and Unattended Settings*

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Study objective: We compared the validity of a new portable polysomnographic recorder against a laboratory-based polysomnographic system from the same manufacturer.

Design and patients: Simultaneous, full polysomnographic recordings from the portable device (PSGP) and the laboratory-based system (PSGL) were obtained using separate sets of sensors on 20 patients referred for investigation of sleep apnea.

Setting: After initial optimization of signals, the portable device was left unattended in 10 of the patients (to simulate home studies), while in the other 10 the signals were reviewed on a laptop computer screen and adjustments to electrode or sensor placement made as needed during the studies. Recordings were manually scored by a technologist blinded to the origin of the data.

Measurements and results: The quality of signals was comparable between the PSGP and PSGL studies, apart from a slight decrease in respiratory signal quality during PSGP studies that led to reduced confidence in respiratory event scoring. SaO2 signal loss was also greater in unattended PSGP. There was good agreement between PSGP and PSGL for sleep variables and the apnea-hypopnea index ($r = 0.99$). The periodic limb movement index was slightly lower during unattended PSGP. Blinded physician assessment of the records led to a recommendation for repeat studies due to poor signal quality in one (10%) attended and one (10%) unattended portable recording. There was no significant discordance between PSGP and PSGL in the final diagnostic formulations.

Conclusion: Portable polysomnography is a viable alternative to laboratory-based polysomnography and may be improved further by better sensor attachment.

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Key words: home monitoring; portable polysomnography; sleep apnea

Abbreviations: AHI = apnea-hypopnea index; ASDA = American Sleep Disorders Association; Att = attended; EMG = electromyogram; EOG = electro-oculogram; MB = megabyte; NS = not significant; OSA = obstructive sleep apnea; PLM = periodic limb movement; PSGL = laboratory-based polysomnograph; PSGP = portable polysomnography; REM = rapid eye movement; SaO2 = arterial oxygen saturation; TST = total sleep time; Unatt = unattended

A laboratory-based polysomnograph (PSGL), with continuous overnight monitoring and recording of multiple electrophysiologic and respiratory channels, is still the gold standard for diagnosis and assessment of treatment in sleep disorders. The high prevalence of sleep disorders and the increasing recognition of their importance in clinical practice has led to a remarkable increase in the demand for polysomnography services over recent years. PSGL studies are expensive, and in many instances demand for these services has outstripped supply. In response to this demand, a variety of portable devices have been developed that allow sleep studies to be performed in the home. Portable devices may be particularly valuable for epidemiologic studies and for subgroups of patients who have difficulty accessing main laboratory facilities, either because they live in remote communities or because of severe disability. The role of portable polysomnography (PSGP) in the evaluation of sleep apnea remains controversial and has been the subject of recent editorial comment and American Sleep Disorders Association (ASDA) statements.

Portable EEG recording devices have been used successfully for many years by neurologists to inves-
tigate epilepsy.10,11 However, most of the ambulatory or screening polysomnographic devices used until recently recorded only a limited number of respiratory variables on their digital storage devices, and many of them were limited in recording of electrophysiologic variables that are necessary for the accurate staging of sleep (ie, EEG, electro-oculograms [EOGs], and submental electromyogram [EMG]). Sleep quantity and quality either were not measured or were assessed indirectly using body movement1 or a combination of body and eye movements.6 The latter approach appears to provide a reasonable estimate of total sleep time (TST), but it discriminates between sleep stages poorly.6 Actigraphy appears to provide reliable estimates of TST in normal subjects and patients with insomnia, but its reliability has not been systematically investigated in sleep apnea populations.9 A problem common to all such screening devices is that subtle alterations in sleep architecture (eg, brief arousals) that are important in disorders such as upper airways resistance syndrome cannot be discriminated.

It would be desirable if all physiologic variables could be recorded in the home with PSGP devices. Such a device that employs a magnetic-tape storage system has been available for a number of years and was used in a previous study by this group to record data from patients in the home setting.13. It provides accurate sleep stage data when the recordings are visually scored2 and a full range of respiratory recordings suitable for sleep apnea evaluation.9 However, the technology in this recorder has been superseded by less expensive high-density digital storage devices and further miniaturization of digital electronic components. A number of digital recording devices suitable for full PSGP have recently been released commercially. One of these devices (Compumedics PS1 Series portable system; Compumedics Pty Ltd; Melbourne, Australia) conforms to the ASDA standards-of-practice requirements for a Level II polysomnographic recorder. It allows full disclosure of electrophysiologic, respiratory, leg movement, and body position signals for manual and/or computer-assisted scoring. The present study was designed to compare this device with an established laboratory-based polysomnographic system (PSGL) in terms of (1) the technical quality of data recorded with respect to its suitability for sleep staging and respiratory event scoring; (2) derived indices such as sleep stages and apnea-hypopnea index (AHI), and (3) the final interpretive result. Half of the PSGP recordings were obtained in an unattended setting in the laboratory in an attempt to simulate the conditions of home monitoring and assess the quality of data thus recorded.

Materials and Methods

Study Design

A random sample of 20 male patients with symptoms of loud snoring and daytime sleepiness, referred to the sleep laboratory for diagnosis of suspected obstructive sleep apnea (OSA), was studied. PSGL studies were performed on each patient using a laboratory-based computerized system (Compumedics S-Series Sleep System). The technicians performed the PSGL recordings in the usual manner, taking corrective measures when necessary to optimize signal quality. Simultaneous polysomnography was performed using a portable system (PSGP [Compumedics PS1-Series Portable Sleep System]) and a separate set of sensors. For the PSGP recordings, patients were randomly allocated into two groups of 10: an attended (Att) and an unattended (Unatt) group.

The procedures adopted for the attended and unattended portable PSG recordings (Att-PSGP and Unatt-PSGP) were as follows: during Att-PSGP, data were displayed in real time on a laptop computer regularly monitored by the attending sleep technologist. The technologist was instructed to attend the patient to rectify any problems with signal quality (eg, to reattach a sensor). During Unatt-PSGP, no laptop computer was used, and after initial optimization of signals, no technical intervention was permitted during the period of recording.

PSG Sensors and Montage

To keep PSGL and PSGP signals completely independent from one another, two separate sets of sensors and electrodes (positioned closely together) were used on each patient. The order and position of sensor/ electrode placement was randomized. Care was taken to ensure that the PSGL and PSGP recordings began and ended at the same times.

The montage, electrodes, and transducers used for PSGL and PSGP recordings were identical, with the exception of the oximeters and the inductive plethysmography signal filtering/amplification systems (see below). Gold electrodes were used to record one channel of EEG (C3–A2), right and left EOGs, and submental EMG. Other parameters recorded included ECG, right and left leg movements (piezoelectric cell; Compumedics), arterial oxyhemoglobin saturation (SaO2 measured by finger probe pulse oximetry [For the Compumedics S-Series Sleep System: Criticare 504 oximeter; Criticare Systems Inc; Waukesha, WI. For the PS1-Series: Portable system oximeter; MSA; Pittsburgh, PA]). Body position (mercury switch; Compumedics), airflow (oronasal thermistor; Compumedics) and thoracic and abdominal efforts (inductive plethysmography bands; Vitalog Respironics; Redwood City, CA) were also recorded. The effort signals were amplified and filtered differently as follows: With the S-Series system, the input signal was supplied via a Vitalog interface box (Stand-Alone Medical Monitoring Interface, or SAMMI) that was also responsible for amplification and filtering of output signals. With the PS1-Series Portable, the Vitalog interface box was not used, and effort signal amplification and filtering were performed within the portable unit. Transducers were also mounted in the patient interface boxes of each system to monitor sound and to determine lights on/off.

Computerized Recording and Display Equipment

Hardware: The hardware used for data storage and display were different for the PSGL and PSGP. PSGL data were recorded on a 220-megabyte (MB) hard disk and displayed on a high-resolution 20-inch screen (resolution, 1,024 × 768 pixels; Multisync 6FG; NEC Corp; Tokyo, Japan). PSGP data were recorded on a 220-megabyte (MB) hard disk and displayed on a high-resolution 20-inch screen (resolution, 1,024 × 768 pixels; Multisync 6FG; NEC Corp; Tokyo, Japan).
who was blinded to the origin of the data assessed each study. The physician noted whether the technical quality of the data was excellent (no signal failure), good (signal failure occurred in the study but diagnostic confidence was not significantly impaired), poor (signal failure significantly reduced diagnostic confidence) or inadequate (serious signal failure necessitated repeat study). The physician also gave a final diagnosis, and sleep apnea was categorized as mild (AHI = 15–25), moderate (AHI = 26–40), or severe (AHI > 40). The moderate and severe categories could include patients from the adjacent less severe category of AHI if either severe desaturation (ie, nadir < 70%, or > 25% desaturations < 85%) or marked sleep fragmentation (arousal index > 15 per hour of sleep) was present in combination with daytime sleepiness (Epworth Sleepiness Score > 12).

Data Analysis

Data recorded during PSGP were converted and downloaded onto the Compumedics S-Series Sleep System to enable all studies to be analyzed using the same analysis software (Compumedics Replay Version 4.0) and high-resolution SVGA screen.

Manual analysis of all the studies was performed by a single trained scorer (IM) who was blinded to the origin of the data. Standard methods were used to score sleep stages.14 Sleep arousals were scored from the one EEG signal but otherwise conformed to ASDA criteria.15 Abnormal respiratory events were defined as follows: obstructive apnea = cessation of airflow for a minimum of 10 s with continued thoracoabdominal wall movement; central apnea = cessation of airflow and thoracoabdominal wall movements for a minimum of 10 s; mixed apnea = cessation of airflow and thoracoabdominal wall movements for at least the duration of one respiratory cycle, followed by a return of respiratory efforts but continued absence of airflow, the duration of the event being a minimum of 10 s; hypopnea = a minimum of 50% reduction in amplitude of airflow signal or both thoracic and abdominal efforts for at least 10 s. We did not include desaturation as a criterion for scoring apneas or hypopneas. Periodic limb movements (PLMs) were scored according to standard criteria.16

Outcome Measures

Signal Quality: Signal quality was assessed in two ways. First, to determine the raw signal quality, the percentage of study time that individual signals were either absent or uninterpretable was calculated. Second, to determine the influence of any such signal loss on the ability to score the PSGs, the technologist noted the percentage of study time that sleep stage could not be determined or abnormal respiratory events could not be detected or properly characterized (eg, obstructive vs central apneas). This second method of assessing signal quality was used because, in practice, it is found that a skilled sleep technologist can often continue to score the sleep record with confidence when one or more signals is absent or severely distorted by artifact (eg, a single EOG lead or one of the respiratory effort signals). We considered that this additional method of data analysis would therefore provide useful practical information regarding the reliability of the PSGP device.

Derived Values: Derived values included sleep stages (total number of minutes spent in each individual sleep stage), TST (total number of minutes of sleep recorded after “lights out”), sleep efficiency [(time asleep/time in bed after “lights out”) × 100%], AHI (number of apneas plus hypopneas per hour of sleep), arousal index (number of arousals per hour of sleep), and PLM index (number of PLMs per hour of sleep).

Clinical Interpretation: To assess whether signal quality affected the confidence or accuracy of the final interpretation of the polysomnographic recording, an experienced sleep physician

Recorded on a 20-MB PCMCIA card and (during the Attended studies) displayed on a Toshiba T4700CS laptop computer with a 9-inch VGA active matrix screen.

Software: Both PSGL and PSGP systems utilized specific recording software developed by Compumedics. The montages used were the same for each system and the majority of sampling rates were the same (EEG, 125 Hz; EOG, 50 Hz; EMG, 125 Hz; respiratory effort and flow, 25 Hz). The leg movement sampling rate was 25 Hz for PSGP and 50 Hz for PSGL. The SaO2 sampling rate was 1 Hz for PSGP and 5 Hz for PSGL. For PSGL, on-line gain and signal filtering adjustments were possible during the study and were performed as required; these adjustments were not possible during PSGP.

Statistics

Since most parameters that were examined were not distributed normally, comparisons between PSGL and PSGP data (Att and Unatt) were made using the Wilcoxon signed rank test. Correlations were performed using regression analysis. Bland-Altman plots17 were constructed to assess the degree of agreement between PSGP and the gold standard of PSGL. A p value of 0.05 or less was considered to be statistically significant.

Results

The Att-PSGP and Unatt-PSGP patient groups did not differ from each other with respect to age ([mean ± SD] 46.1 ± 5.4 vs 54.4 ± 2.7 years; not significant [NS]), body mass index (31.5 ± 1.1 vs 29.6 ± 1.7 kg/m2; NS), or study duration (401.1 ± 17.7 vs 408.4 ± 16.2 min; NS). The primary diagnoses established by PSGL in the 20 patients were as follows: OSA, n = 10 (classified as severe, n = 5; moderate, n = 1; and mild, n = 4); probable upper airways resistance syndrome, n = 3; simple snoring, n = 2; PLMs, n = 3; and no sleep disorder, n = 2. Five of the patients with sleep-disordered breathing also had mild PLMs.

Signal Quality

Individual Signal Failures: In Table 1 the percent of study time that individual signals (excluding SaO2) were either absent or uninterpretable due to poor quality, are given for Att-PSGP and for Unatt-PSGP, and compared with data obtained during simultaneous PSGL. In general, the percentage of time that individual signals were lost or uninterpretable was very small (< 5%) and did not differ between the portable and laboratory polysomnographies. The EMG signal during Att-PSGP was unreliable due to an undetected fault in one of the two pairs of EMG recording electrodes used with the portable device. This set of electrodes was used more frequently in the attended than the unattended portable studies, leading to a significant difference in EMG quality in Att-PSGP vs PSGL. During Unatt-PSGP, there was
a significant increase in the percentage of study time that the airflow signal was absent or uninterpretable compared to during PSGL.

The percentage of study time that the SaO₂ signal was absent (Fig 1, a) did not differ between Att-PSGP and PSGL studies (4.4 ± 3.6% and 0.39 ± 0.33, respectively; NS). However, SaO₂ signal loss was greater during Unatt-PSGP than during PSGL (12.8 ± 7.2% vs 0.2 ± 0.1%; p < 0.05). When the SaO₂ signal was analyzed in terms of the actual number of signal drop-outs (irrespective of duration of signal loss) a different pattern was seen (Fig 1, b). Significantly more episodes of signal loss were observed during Att-PSGP than during PSGL, whereas the number of signal drop-outs did not differ between Unatt-PSGP and PSGL. The discrepancy between these two results is explained by the fact that when signals were lost in the unattended setting, the problem was not rectified by a technologist, resulting in a greater duration of signal loss (eg, 55.8% of study time in one recording) for a relatively low number of drop-out episodes.

Polysomnographic Scoring: During PSGL recordings there were few occasions when sleep scoring was considered by the technologist to be seriously compromised because of the absence of one or more electrophysiologic signals or because of excessive signal noise. This occurred in <1% of the study time. There was no difference between PSGP (attended and unattended) and corresponding PSGL studies in the percentage of study time that signals were considered inadequate for sleep scoring (Fig 2, a), despite the problems encountered with poor EMG signals in the portable system (see above and Table 1). The scoring of abnormal respiratory events during PSGL was considered seriously compromised because of absent or poor respiratory signals in <1% of the study time. The percentage of study time that respiratory signals were inadequate for respiratory event scoring was greater during Att-PSGP than during PSGL (Fig 2, b). The difference between Unatt-PSGP and PSGL also approached statistical significance (p = 0.06).

Derived Values

Sleep: TST, sleep efficiency, and the frequency of arousals did not differ between portable and laboratory recordings (Fig 3). Slightly more rapid eye movement (REM) sleep was scored in Att-

Table 1—Polysomnography Signal Failure*

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<tr>
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<th>Attended PSGP</th>
<th>PSGL</th>
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<tr>
<td>EEG</td>
<td>4.43 ± 3.63</td>
<td>0.39 ± 0.33</td>
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<tr>
<td>EMG</td>
<td>54.21 ± 14.97</td>
<td>0.00 ± 0.001</td>
</tr>
<tr>
<td>EOG (L or R)</td>
<td>0.52 ± 0.52</td>
<td>2.78 ± 2.27</td>
</tr>
<tr>
<td>EOG (both)</td>
<td>1.78 ± 1.19</td>
<td>0.35 ± 0.28</td>
</tr>
<tr>
<td>Airflow</td>
<td>2.94 ± 2.33</td>
<td>0.32 ± 0.21</td>
</tr>
<tr>
<td>Effort (T or A)</td>
<td>0.23 ± 2.61</td>
<td>2.36 ± 0.96</td>
</tr>
<tr>
<td>Effort (both)</td>
<td>0.83 ± 0.56</td>
<td>0.01 ± 0.01</td>
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<table>
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<tr>
<th></th>
<th>Unattended PSGP</th>
<th>PSGL</th>
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<tbody>
<tr>
<td>EEG</td>
<td>0.95 ± 0.77</td>
<td>0.09 ± 0.07</td>
</tr>
<tr>
<td>EMG</td>
<td>17.53 ± 9.87</td>
<td>0.68 ± 0.68</td>
</tr>
<tr>
<td>EOG (L or R)</td>
<td>0.07 ± 0.05</td>
<td>0.11 ± 0.07</td>
</tr>
<tr>
<td>EOG (both)</td>
<td>0.43 ± 0.30</td>
<td>0.26 ± 0.22</td>
</tr>
<tr>
<td>Airflow</td>
<td>8.07 ± 5.31</td>
<td>0.81 ± 0.55</td>
</tr>
<tr>
<td>Effort (T or A)</td>
<td>3.35 ± 1.63</td>
<td>1.19 ± 0.59</td>
</tr>
<tr>
<td>Effort (both)</td>
<td>0.06 ± 0.06</td>
<td>0.49 ± 0.35</td>
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*Signal quality expressed as percentages of study time that raw signals were absent or uninterpretable (mean ± SEM). Parameters are as described in Materials and Methods. EOG data refer to interpretability of signals from either left or right electrodes (L or R), and from both left and right together (both). Similarly, respiratory effort data are given for either thoracic or abdominal (T or A), and for both signals together (both).

†p < 0.05.
PSGP studies compared with PSGL (Fig 4). This difference was attributable to poor EMG signal quality (faulty electrode used in some of the portable studies) that affected the accuracy of REM sleep scoring. The duration of non-REM sleep stages did not differ between PSGP (attended or unattended) and PSGL recordings (Fig 4).

Sleep-disordered Breathing and PLMs: The AHI did not differ during Att-PSGP or Unatt-PSGP compared with PSGL (Fig 5). The PLM index was lower during Unatt-PSGP than PSGL (Fig 5).

There was good agreement between the AHIs obtained during PSGP and PSGL by least squares linear correlation (Fig 6). The diagnostic sensitivity and specificity of PSGP recordings to detect sleep apnea using a diagnostic cut-off of AHI > 10/h were 80 and 90%, respectively. For a diagnostic cut-off of AHI > 20/h, the corresponding values were 100 and 100%, respectively. The Bland-Altman plots for AHI, sleep efficiency, and arousal index are shown in Figure 7. The mean difference between PSGP- and PSGL-derived AHI, sleep efficiency, and arousal index were very small and did not appear to change systematically across the range of measurement. There were, however, a few outlying results. The two AHI outliers in Figure 7, A (difference between PSGP- and PSGL-derived AHI > 2 SD of the mean) led to a difference in diagnostic classification (see below). The one outlying result in sleep efficiency (Fig 7, B) resulted from poor electrophysiologic signals during Att-PSGP.

Physician Interpretation of Data

The sleep physician ranked the quality of all PSGL recordings as either good or excellent, whereas seven of the 10 Att-PSGP studies and six of the 10 Unatt-PSGP studies were considered good or excellent. One Att-PSGP and one Unatt-PSGP study were considered inadequate for reporting and a repeat study was recommended.

Comparisons of the diagnostic formulations made from PSGP and PSGL recordings were possible in nine of 10 study pairs in both the attended and unattended components of the study (one attended PSGP and one unattended PSGP were considered of insufficient technical quality to enable confident interpretation). There was diagnostic concordance between Att-PSGP and PSGL in eight of nine patients, and between Unatt-PSGP and PSGL in eight of nine. The discordance in final diagnostic formulation was slight and of little clinical relevance: mild OSA vs probable upper airways resistance (Unatt-PSGP vs PSGL) and moderate OSA vs mild OSA (Att-PSGP vs PSGL).

Discussion

The present study is, to our knowledge, the first to directly and simultaneously compare the reliability of a portable device capable of full polysomnography with a laboratory-based polysomnographic recording system. Full polysomnographic devices are being used in the home for epidemiologic studies and may be valuable, in some instances, for clinical studies. Of particular interest in the present study, therefore,
were the results from the portable device used in an unattended setting. In general, we found that there was good agreement between the portable and laboratory-based systems with respect to signal quality and derived values (e.g., sleep stages and frequency of sleep-disordered breathing), independent of whether the recordings were attended or unattended. The PSGP provided technically reliable and diagnostically accurate data in approximately 90% of cases.

**Technical Adequacy of PSGP vs PSGL**

A feature of the present study was the generally high level of reliability of electrophysiologic recordings using the portable device, even in the unattended setting. The single exception to this was the presence of poor EMG signals in some of the PSGP recordings due to a faulty electrode that was undetected until late in the study. We consider that the problem we encountered with the EMG electrode during Att-PSGP recordings was serendipitous and does not signify any design weakness of the PSGP device. It could equally have occurred during the PSGL recordings. However, the laptop screen used during Att-PSGP studies was not ideal for assessing the quality of the signals and probably contributed to the late detection of this faulty component. The problem with poor EMG signals during Att-PSGP studies did not significantly affect the confidence of the technologist in scoring sleep, but it did lead to slight inaccuracy in REM staging (see below).

It is generally acknowledged that an accurate description and quantification of sleep would add significantly to the diagnostic accuracy and utility of PSGP devices. Several devices have made attempts to quantify sleep using simplified sleep recording techniques (e.g., body movement supplemented by eye movement) or software to perform on-line sleep analysis from standard electrophysiologic signals. It appears that the reluctance to employ full electrophysiologic monitoring in portable devices to this time has been due, at least in part, to concern than there would be a high signal failure rate. Our study suggests that this fear may not be justified. The mean time that signals were considered inadequate for sleep scoring using the portable device was 4% or less. This finding concurs with the experience of neurologists who have successfully used portable EEG for more than 20 years to monitor patients with epilepsy. The other impediment to collecting electrophysiologic data in portable sleep studies had been, until recently, the unavailability of miniature storage devices of sufficient storage capacity (at least 20 MB) for overnight, high-frequency (125 to 250 Hz), multichannel digital recordings. This problem has now been solved with the advent of newer portable storage devices such as that used in the Compumedics P-Series Portable Sleep System.

There was a small increase in the percentage of

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**Figure 3.** Total sleep time (min; top), sleep efficiency (percent; middle), and arousal index (events per hour of sleep; bottom) compared between PSGP and PSGL. There was close agreement for all variables between PSGP studies (attended and unattended) and PSGL studies.
study time that respiratory effort and/or flow signals in PSGP recordings were poor and judged by the technologist to be suboptimal for respiratory event scoring. This was generally caused by falls in the amplitude of signals (e.g., due to body position change) that could not be rectified by on-line gain changes. The software on the PSGP device does not allow on-line changes to signal gain or filtering. There were significant problems with the Sa_o_2 sensor during portable studies. Based on the higher frequency of signal drop-outs during attended portable studies, it appears that the sensor used with the portable device may be more prone to signal failure or drop-out than the one used in the main laboratory system. This problem was compounded during unattended studies when signal absence was undetected in some studies for relatively long periods. These problems with respiratory signals are well recognized, particularly in unattended recording settings. The most common signal problems encountered by White et al. who used a portable device in the home, were respiratory effort, Sa_o_2, and airflow signals, in decreasing order of importance. In one study, 10% of home oximetry records were rejected because of signal failure; in another home study using a Level III device, data loss was 15%. It

![Figure 4](http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/21894/)  
**Figure 4.** Duration of sleep stages (min) compared between PSGP and PSGL. There was good agreement between PSGP and PSGL studies in all non-REM sleep stages (top), and between Unatt-PSGP and PSGL in REM sleep time (bottom). Slightly more REM was scored in Att-PSGP studies than in simultaneous PSGL studies.

![Figure 5](http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/21894/)  
**Figure 5.** Comparisons between PSGP and PSGL. **Left**, AHI. **Right**, PLMs. No significant differences in AHI were observed between the PSGP and PSGL studies. A lower frequency of PLMs found in Unatt-PSGP vs PSGL studies.
should be noted that the definition of sleep-disordered breathing events used in this study did not include desaturation. Had it done so, the respiratory event scoring would likely have been more problematic. Finally, it is acknowledged that the Unatt-PSGP recordings were performed in the laboratory and might underestimate the frequency of signal failures likely to occur in true home studies.

Derived Indices: PSGP vs PSGL

Apart from a slight overestimation of REM sleep in Att-PSGP recordings that can be attributed to a faulty EMG electrode connection, there was very good agreement between portable and laboratory-based devices with respect to indices of sleep. It is important to note that TST used for calculations of the frequency of disordered breathing events and PLMs did not differ between PSGP and PSGL recordings. The small increase in the rate of failed or inadequate respiratory effort or flow signals during portable studies did not lead to any significant disagreement in AHI between the two methods. It is possible that, had we incorporated a reduction in Sa\textsubscript{O\textsubscript{2}} into the definition of hypopnea, as have some other investigators, we would have observed a discrepancy in AHI between Unatt-PSGP and PSGL because of the higher Sa\textsubscript{O\textsubscript{2}} signal failure time in Unatt-PSGP studies.

The PLM index was significantly lower in Unatt-PSGP compared with PSGL studies. We do not have any satisfactory explanation for this finding. It did not appear to be due to errors in assessing TST or to displacement of leg movement sensors during Unatt-PSGP studies. All patients found during PSGL studies to have moderate to severe PLMs (PLM index > 20/h) were correctly diagnosed by PSGP, and there were no false-positive diagnoses of moderate to severe PLMs from PSGP recordings.

Summary and Conclusions

This study has demonstrated a high level of agreement between simultaneous polysomnographic recordings using a newly released Level II portable PSG device and its parent laboratory-based PSG system. Apart from a serendipitous problem with a faulty EMG electrode, electrophysiologic signals were of good quality during PSGP recordings and there were no significant discrepancies in sleep staging parameters between portable and laboratory-based polysomnographic studies. The respiratory signals were of slightly inferior quality during PSGP recordings. In particular, the Sa\textsubscript{O\textsubscript{2}} sensor appeared to be prone to signal failure that led to significant periods of Sa\textsubscript{O\textsubscript{2}} signal loss in the unattended setting. An improved Sa\textsubscript{O\textsubscript{2}} sensor, improved method of sensor attachment, or incorporation of an “off finger”
alarm would appear to be necessary before this portable device is used routinely in an unsupervised setting. Also, in the unattended setting, respiratory flow and effort signals were less reliable. Notwithstanding these findings, the indices of sleep-disordered breathing were in close agreement between portable and PSGL recordings. A sleep physician assessed that 90% of the portable recordings were satisfactory for clinical interpretation. There were no significant diagnostic discrepancies with respect to sleep-disordered breathing. While there was a slight underestimation of the frequency of PLMs in the unattended PSGP studies, all patients with moderate to severe PLMs were accurately diagnosed by PSGP. These results are encouraging and suggest that this portable device may be useful in diagnostic evaluations of patients with sleep disorders in unattended settings (eg, the home). However, further studies are needed to confirm PSGP’s reliability in unattended settings remote from the laboratory.

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