Practice Parameters for the Use of Actigraphy in the Assessment of Sleep and Sleep Disorders: An Update for 2007

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Background: Actigraphy is increasingly used in sleep research and the clinical care of patients with sleep and circadian rhythm abnormalities. The following practice parameters update the previous practice parameters published in 2003 for the use of actigraphy in the study of sleep and circadian rhythms.

Methods: Based upon a systematic grading of evidence, members of the Standards of Practice Committee, including those with expertise in the use of actigraphy, developed these practice parameters as a guide to the appropriate use of actigraphy, both as a diagnostic tool in the evaluation of sleep disorders and as an outcome measure of treatment efficacy in clinical settings with appropriate patient populations.

Recommendations: Actigraphy provides an acceptably accurate estimate of sleep patterns in normal, healthy adult populations and inpatients suspected of certain sleep disorders. More specifically, actigraphy is indicated to assist in the evaluation of patients with advanced sleep phase syndrome (ASPS), delayed sleep phase syndrome (DSPS), and shift work disorder. Additionally, there is some evidence to support the use of actigraphy in the evaluation of patients suspected of jet lag disorder and non-24hr sleep/wake syndrome (including that associated with blindness). When polysomnography is not available, actigraphy is indicated to estimate total sleep time in patients with obstructive sleep apnea. In patients with insomnia and hypersomnia, there is evidence to support the use of actigraphy in the characterization of circadian rhythms and sleep patterns/disturbances. In assessing response to therapy, actigraphy has proven useful as an outcome measure in patients with circadian rhythm disorders and insomnia. In older adults (including older nursing home residents), in whom traditional sleep monitoring can be difficult, actigraphy is indicated for characterizing sleep and circadian patterns and to document treatment responses. Similarly, in normal infants and children, as well as special pediatric populations, actigraphy has proven useful for delineating sleep patterns and documenting treatment responses.

Conclusions: Recent research utilizing actigraphy in the assessment and management of sleep disorders has allowed the development of evidence-based recommendations for the use of actigraphy in the clinical setting. Additional research is warranted to further refine and broaden its clinical value.

Keywords: Circadian rhythms, actigraphy, advanced sleep phase syndrome, delayed sleep phase syndrome, shift work disorder

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1. INTRODUCTION

ACTIGRAPHY INVOLVES USE OF A PORTABLE DEVICE THAT RECORDS MOVEMENT OVER EXTENDED PERIODS OF TIME, AND HAS BEEN USED EXTENSIVELY IN the study of sleep and circadian rhythms. Since the publication of the last American Academy of Sleep Medicine (AASM) practice parameters on the use of actigraphy,[1] there has been an explosion in the number of research articles utilizing actigraphy to estimate sleep and circadian rhythms. In response to this new literature, and the growing use of actigraphy in clinical sleep medicine, the AASM Standards of Practice Committee (SPC) undertook the development of these revised guidelines on the clinical use of this technology.

Since the last review, additional literature has been published that addresses the use of actigraphy in the evaluation of insomnia, circadian rhythm sleep disorders, sleep related breathing disorders, determination of response to therapy, and in the evaluation of sleep patterns among special populations. This literature, in combination with growing clinical experience with actigraphy, led to the inclusion of actigraphy as a measure of sleep duration and sleep patterns in the diagnostic criteria for several specific sleep disorders in the second edition of the International Classification of Sleep Disorders.[2] Actigraphy is listed as a diagnostic tool in the ICSD-2 primarily when sleep patterns must be assessed over time, making polysomnography impractical. For example, the ICSD-2 diagnostic criteria for most circadian rhythm disorders requires demonstration of abnormalities in the timing of the habitual sleep pattern using either actigraphy or sleep logs for seven days or more. The ICSD-2 also suggests that actigraphy may be used to document inconsistencies between objective and subjective measures of sleep timing in paradoxical insomnia, and as an aid in assessment of habitual sleep time and circadian pattern in patients with behaviorally induced insufficient sleep syndrome and idiopathic hypersomnia with and without long sleep times. Actigraphy is additionally recommended as an adjunct to the Multiple Sleep Latency Test to document a stable sleep pattern and adequate sleep times prior to the test.

However, it should be noted that although the ICSD-2 reflects consensus among experts regarding disease classification and di-

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agnostic criteria, there is great variability in the evidence supporting these diagnoses and criteria. In some cases, only face validity and clinical experience guided the criteria, while in others there was a wealth of supportive research evidence. The purpose of the present document is to provide an updated, evidence-based review of the use and indications for actigraphy in the evaluation of sleep and sleep disorders. The title of the 2002 actigraphy parameter paper was modified from that of the first one, published in 1995, which was titled: "Practice Parameters for the Use of Actigraphy *in The Clinical Assessment Of Sleep Disorders.*" The 2002 paper was titled: "Practice Parameters for the Role of Actigraphy *in the Study of Sleep and Circadian Rhythms*: An Update for 2002." This change implied an emphasis on the uses of actigraphy in research. However, the current parameter paper returns to the original focus on an evidence-based review of the use of actigraphy in the assessment and management of sleep disorders in the clinical setting.

2. METHODS

The SPC of the AASM commissioned among its members those individuals with expertise in the use of actigraphy to conduct this review. These content experts were appointed in January 2006 to review and grade evidence in the peer-reviewed scientific literature regarding the use of actigraphy in sleep and circadian rhythm disorders. A computerized search was performed using the search terms actigraph, actigraphy, actigraphic monitoring, actigraphic recording, actimeter, actometer, wrist activity, rest activity, or sleep-wake and found 3641 titles. These were then cross-checked with 32,211 titles found using the search terms: sleep disorders, circadian rhythm, or sleep, to yield 1884 titles. This total was then limited to those published between 2001 and 2005 with a minimum of 8 subjects studied by actigraphy, those in English, those from the core clinical journals, and those with emphasis on diagnosis (using the Ovid search engine) as a modifier to yield 155 articles. After review of abstracts from these articles to determine if they met inclusion criteria, plus of articles identified by pearling, a total 108 articles (see accompanying evidence table) were included. Initial data extraction, preliminary evidence grading in accordance with the standards in Table 1, and initial data entry into evidence tables was performed by professionals commissioned by the AASM SPC to expedite the review process. This classification of evidence, based on suggestions of Sackett,[3] is similar to that of the prior review and practice parameter paper commissioned by the AASM SPC.[1] Some modifications of evidence level criteria were applied by the AASM SPC to this update of the practice parameters for actigraphy to insure the evidence classification was in keeping with recent updates in the literature for the field of evidence grading[4] (see Table 1). All evidence table entries were reviewed and, if appropriate, revised by AASM SPC content experts. Thus, all evidence grading was performed by independent review of the article by two experts, including members of the SPC; areas of disagreement were addressed, and, if needed, the chair of the AASM SPC arbitrated the final decision on evidence level.

Three methodological issues engendered considerable debate and discussion by the SPC:

1. Blinding. Typically, evidence graded as Level 1 according to Sackett criteria requires blinding. In evaluations of the therapeutic efficacy of medications, this means that neither the patients nor the researchers know whether the intervention is active drug or placebo. In the case of the evaluation of actigraphy in comparison to a reference standard (such as polysomnography), this could be interpreted as requiring that the person scoring actigraphy is unaware of the results of polysomnography scoring. Few studies actually specified whether this was the case. Given the technology used and the typical methodology currently used for scoring actigraphic recordings (computer executed scoring programs), it is unlikely that researchers remembered the results of the polysomnograms or simultaneously reviewed both recordings. However, even when using computer scoring of actigraphic data, most situations require manual input of start and stop times. Thus, after considerable discussion, the SPC elected the more conservative approach and required an explicit declaration of blinding for a study to receive a Level 1 rating. Some members of the Committee felt that this may have underestimated the quality of the evidence for use of actigraphy.

2. Reference standard. The majority of the studies evaluated actigraphy in comparison to a reference standard. In some cases these were objective measures, such as polysomnography or dim light melatonin onset; in other cases the reference was subjective, including sleep logs and estimates of sleep quality. For the purposes of this review, we chose appropriate reference standards based on specific diagnostic categories. Reference standards for insomnia included PSG and/or sleep logs; for circadian rhythm sleep disorders, PSG, phase markers, and/or sleep logs; for sleep apnea, PSG; for restless legs syndrome and periodic limb movements during sleep, PSG; for infants, caregiver reported observations; for elderly or demented persons, phase markers, sleep logs, and/or caregiver reports; and for healthy controls, PSG, phase markers, or sleep logs. The inclusion of research using subjective reference standards (such as sleep logs, self-reported sleep, and caregiver report) reflects the fact that many studies required the study of patients over multiple sleep cycles or other circumstances where traditional PSG as a reference standard was impractical (e.g., infants and nursing home residents). As such, research which compares actigraphy to subjective reference standards does not necessarily imply a greater accuracy with either method, but it does provide evidence as to the level of agreement between these methods. In addition, some studies did not compare actigraphy with a reference standard but were useful for this review for other reasons. For example, some studies used actigraphy to assess treatment effects, or compared results from one actigraphy scoring algorithm against another. As in the prior 2002 actigraphy review, the SPC elected to include evidence from these studies which did not compare actigraphy to a reference standard but otherwise provided important information for the current review. However, there was a change in the grading criteria for these studies, where those studies which did not directly compare results of actigraphy with a reference standard within participants, but did provide data that allowed comparison of group means from actigraphy data and appropriate reference standards, could be scored as Level 3, rather than Level 4 or 5, as in the 2002 actigraphy review (see Table 1).

3. What does actigraphy measure? Many studies used actigraphy data to estimate polysomnographic measures such as total sleep time or wake after sleep onset. However, actigraphy simply measures movement of a limb. Although it can be highly sensitive and there are sophisticated algorithms that purport to accurately estimate other parameters, it does not measure the same param-

eters as an electroencephalogram. It therefore does not measure sleep as it is commonly defined[5] and does not measure the subjective experience of sleep (as do sleep logs and questionnaires). In addition, systematic discrepancies between actigraphy and these measures have been documented. For example, actigraphy generally underestimates sleep onset latency because many subjects are inactive and awake for a period of time prior to electroencephalographically defined sleep.[6,7] Likewise, a recent epidemiologic study reports systematic overestimation of sleep time by sleep logs as compared to actigraphy.[8] On the other hand, insomnia patients frequently underestimate TST in their sleep logs.[9] Reflecting these issues, in the current report, actigraphy will generally be described as measuring "sleep pattern" (defined as the circadian pattern of sleep and wakefulness over multiple sleep cycles) and the presence or absence of increased wake time after sleep onset. The exception to this will be in the section where total sleep time during one night of testing is estimated by actigraphy as an aid in the evaluation of sleep apnea and in the calculation of the apnea-hypopnea index in patients with suspected sleep apnea.

On the basis of this review the AASM SPC developed the recommendations included in this paper. In all but one condition, that regarding the use of actigraphy in hypersomnia, the recommendations were based on evidence from studies published in peer-reviewed journals that were evaluated as noted above and specified in the description accompanying each recommendation. In developing the recommendation regarding use of actigraphy in hypersomnia, there was insufficient scientific data, but the SPC felt clinical guidance was indicated for use of actigraphy in this condition, so the Rand/UCLA Appropriateness Method was used to develop the recommendation by identifying the degree of agreement among the sleep experts in the SPC after review of the limited data available. The Rand/UCLA Appropriateness Method[10] combines the best available scientific evidence with the collective judgment of experts to yield statements regarding the appropriateness of performing procedures. Our expert panel rated the appropriateness of this indication in two rounds by individually completing rating sheets. Based on these ratings, we classified the indication as appropriate, uncertain, or inappropriate. We determined that if there were strict agreement that the procedure was appropriate, it would be assigned an "option" level recommendation. The certainty of all the other recommendations was assigned according to available evidence levels, as noted in Table 2.

These practice parameters define principles of practice that should meet the needs of most patients in most situations. These guidelines should not, however, be considered inclusive of all proper methods of care or exclusive of other methods of care reasonably expected to obtain the same results. The ultimate judgment regarding appropriateness of any specific therapy must be made by the physician and patient, in light of the individual circumstances presented by the patient, available diagnostic tools, accessible treatment options, resources available, and other relevant factors.

The AASM expects these guidelines to have an impact on professional behavior, patient outcomes, and, possibly, health care costs. These practice parameters reflect the state of knowledge at the time of publication and will be reviewed, updated, and revised as new information becomes available. This practice parameter paper is referenced, where appropriate, with articles to support the recommendation(s). New recommendations, as well as those that are the same as, similar to, or an expansion of recommendations in the prior practice parameters are noted in the text.

3. RESULTS AND RECOMMENDATIONS

Of the 108 studies reviewed for this project (see evidence table), 44 used sleep logs alone as a reference standard, 16 used polysomnography alone, and 10 used both sleep logs and polysomnography with which actigraphic ratings could be objectively compared. Thirty-eight studies did not compare actigraphy to a reference standard, as defined in Table 1. Of the 70 studies that did compare actigraphy to a reference standard, 17 investigated patients with circadian rhythm sleep disorders, 15 studied patients with insomnia (including two studies of depressed patients), 11 were studies of pediatric patients, 7 were studies of elderly subjects with and without dementia, 7 studied normal subjects, and 5 studied patients with sleep related breathing disorders. Eight of the 70 studies were based on a variety of other patient populations including 2 with nocturnal eating disorders, 2 with restless legs syndrome, and one each of the following patient populations: alcoholics, atypical sexual behavior during sleep, cystic fibrosis, and mixed hypersomnias.

The following are recommendations of the AASM SPC and BOD regarding the use of actigraphy in clinical practice. The reviewed literature involved a variety of actigraphic monitors and scoring algorithms. When described in the article, the particular actigraphic device and/or algorithm used are listed in the evidence tables. Clinicians using actigraphy in practice should ensure that they are familiar with the operational characteristics of their equipment for the specific task employed.

3.1 Use of actigraphy in the evaluation of sleep disorders

3.1.1 Actigraphy is a valid way to assist in determining sleep patterns in normal, healthy adult populations (Standard), and in patients suspected of certain sleep disorders. (Option-Guideline-Standard; see specific parameter below)

This is an expansion of the previous standard (that was limited to the validity and reliability in detecting sleep in normal, healthy adult populations) to include specific patient populations, such as patients with insomnia and those suspected of having circadian rhythm sleep disorders. Specific indications for actigraphy will be addressed in the parameters below. In the current review, additional evidence was identified supporting use of actigraphy in normal, healthy controls, and in patients with various sleep disorders. Supportive studies includes nine with evidence Level 1; ten with Level 2; thirty-eight Level 3; six with Level 4 and six graded as Level 5. The conclusion in the preponderance of studies was that actigraphy was correlated with the reference standard (as defined in Table 1), especially for those studies rated by the SPC at higher evidence levels. Pearson r values were reported for total sleep time comparisons between actigraphy and polysomnography in eight studies.[7,9,11-17] The range was 0.15 to 0.92, with an simple average of 0.71. All but the lowest r values were statistically significant. The lowest value was reported studying patients suspected of sleep apnea.[16] Three additional studies reported percentage agreement for total sleep time between actigraphy and polysomnography of 90% in normal subjects,[18] 84% in patients

Table 1—Evidence Levels

1. Blind, prospective comparison of results obtained by actigraphy to those obtained by a reference standard* on an appropriate spectrum of subjects and number of patients.
2. Comparison of results obtained by actigraphy to those obtained by a reference standard* but blinding not specified, not prospective, or on a limited spectrum of subjects or number of patients.
3. Comparison of results obtained by actigraphy to the mean value of a reference standard*, but not direct within-subject comparison, or otherwise methodologically limited.
4. Actigraphy compared to nonstandard reference or group differences shown:
   a. Adequate comparison of results obtained by actigraphy to those obtained by a non-standard reference*; or
   b. Actigraphy not compared to any reference, but actigraphy results demonstrated ability to detect significant difference between groups or conditions in well-designed trial.
5. Actigraphy not adequately compared to any reference, and either
   a. Actigraphy not used in a well-designed trial, or
   b. Actigraphy used in such a trial but did not demonstrate ability to detect significant difference between groups or conditions.

* Reference standards for actigraphic evaluation of sleep and circadian rhythms varied by diagnostic category, and included generally accepted "gold standards," applied in an acceptable manner. By diagnostic category, reference standards for insomnia included PSG and/or sleep logs; for circadian rhythm sleep disorders, PSG, phase markers, and/or sleep logs; for sleep apnea, PSG; for restless legs syndrome and periodic limb movements during sleep, PSG; for infants, caregiver reported observations; for elderly or demented persons, phase markers, sleep logs, and/or caregiver reports; and for healthy controls, PSG, phase markers, or sleep logs. Nonstandard references include such items applied outside their diagnostic category, or other experimental monitors.

with sleep related breathing disorders,[6] and 84% in infants.[19]

With the exception of the study by Penzel et al,[16] most authors concluded that actigraphy is significantly correlated with polysomnography in the measurement of total sleep time. For example, Vallieres and Morin[9] concluded, "these results suggest that actigraphy is a reliable method for assessing sleep-wake patterns and for monitoring treatment response among insomnia patients." In a study of normal subjects, de Souza et al[12] reported that "applying automatic sleep scoring to motor activity resulted in a good accuracy (91%) with both the algorithms … in comparison to PSG." In general, the agreement between actigraphy and polysomnography was higher than the agreement between actigraphy and sleep logs.

3.1.2 Actigraphy is indicated to assist in the evaluation of patients suspected of advanced sleep phase syndrome (ASPS), delayed sleep phase syndrome (DSPS), and shift work sleep disorder (Guideline); and circadian rhythm disorders, including jet lag and non-24-hour sleep/wake syndrome [including that associated with blindness] (Option)

This is a modification of the recommendation from the prior practice parameter paper and expands the role of actigraphy in the diagnosis of circadian rhythm sleep disorders. The use of actigraphy for evaluation of circadian rhythm disorders is based on additional evidence included in this review. Although the evidence

Table 2—AASM Levels of Recommendations

Term	Definition
Standard	This is a generally accepted patient-care strategy, which reflects a high degree of clinical certainty. The term standard generally implies the use of Level 1 evidence, which directly addresses the clinical issue, or overwhelming Level 2 evidence.
Guideline	This is a patient-care strategy, which reflects a moderate degree of clinical certainty. The term guideline implies the use of Level 2 evidence or a consensus of Level 3 evidence.
Option	This is a patient-care strategy, which reflects uncertain clinical use. The term option implies either inconclusive or conflicting evidence or conflicting expert opinion.

The AASM Board of Directors (BOD) approved these recommendations. All members of the AASM SPC and BOD completed detailed conflict-of-interest statements and were found to have no conflicts of interest with regard to this subject.

level was 3–5 in most studies included in the current review, there was good agreement among studies that actigraphy data correlate with polysomnography (when used), sleep logs, and markers of circadian phase in patients with circadian rhythm sleep disorders. There were two Level 3 studies of ASPS or DSPS patients.[20,21] There were four studies of shift work; three were Level 3,[22-24] and one was Level 4b.[25] There was one Level 3 study of blind subjects.[26] There was one Level 3[27] and one Level 4b[25] study of jet lag. Finally, there was one Level 4b study of patients with non-24-hr sleep/wake rhythm.[28]

3.1.3 When polysomnography is not available, actigraphy is indicated as a method to estimate total sleep time in patients with obstructive sleep apnea syndrome. Combined with a validated way of monitoring respiratory events, use of actigraphy may improve accuracy in assessing the severity of obstructive sleep apnea compared with using time in bed. (Standard)

This parameter is a modification of the previous parameter regarding use of actigraphy in evaluation of sleep disordered breathing, and is based on three Level 1 studies.[6,14,29] Since the last parameter paper, several additional studies have evaluated both general purpose actigraphs and specially optimized actigraphy in patients with sleep disordered breathing. Many of the studies have focused on the accuracy or usefulness of actigraphy in estimating total sleep time (TST) in patients with sleep apnea and combining this with tests of respiratory function in order to calculate the most common measure of apnea severity, the apnea-hypopnea index (AHI). Actigraphy can provide an assessment of TST (as it does in some other disorders), and when used along with a valid test for the presence and type of breathing abnormality, can improve the calculation of AHI compared with using time in bed. Several other studies used actigraphy as part of research protocols evaluating sleep pattern of patients with OSA without actually comparing actigraphy results to a sleep standard. No studies propose actigraphy alone as a method of determine the presence of sleep apnea.

One study (Level 1)[14] found a high correlation ($r = 0.90$, $P = 0.0001$) between TST measured by PSG (pTST) and TST estimated by actigraphy (aTST) in patients with obstructive sleep apnea syndrome. Agreement using the Bland and Altman method

found the difference between pTST and aTST was only 2.5 min, but there were notable overestimations and underestimations in three of the 26 patients. In another study, Elbaz et al[29] (Level 1) also found excellent correlation between pTST and aTST ($r = 0.74$, $P < 0.0001$). In the latter study, the AHI, calculated as the apneas plus hypopneas per hour of actigraphically determined sleep (aAHI) was compared with PSG results, again showing excellent correlation ($r = 0.976$, $P < 0.0001$). The aAHI was more accurate than an AHI determined by dividing the apneas plus hypopneas by time in bed, indicating that the addition of actigraphy improved accuracy when estimating the AHI without EEG measured sleep time. In both of these studies, the accuracy of actigraphy evaluated using Bland Altman methods declined in patients with more severe sleep apnea, but in the study of Elbaz et al,[29] only 1 of 20 patients were overclassified with respect to OSA severity by the aAHI (severe instead of moderate severity), and none were underclassified. Thus, it appears that even though the estimate of TST becomes less accurate as apneas and hypopneas increase, the actigraphically derived AHI in most cases accurately classifies moderate or severe sleep apnea. Actigraphically estimated TST in milder cases of sleep apnea appear to be quite accurate, especially if using specially optimized actigraphs and evaluation algorithms. These Level 1 studies were performed in a sleep laboratory, and extrapolation to the home environment could introduce issues not anticipated. However, most other studies reviewed for this paper involved use of actigraphy outside the sleep laboratory and had low data failure rates. Because of the complexity of data analysis, evaluations of sleep disordered breathing severity that use actigraphy to estimate TST should be interpreted with caution by experienced sleep clinicians who are familiar with the performance characteristics of the particular actigraphic system employed.

Another Level 1 study evaluated 228 patients using a special actigraphic system optimized to patients with suspected sleep disordered breathing.[6] Using epoch by epoch comparison of sleep versus wake determined actigraphically versus PSG across all subjects, sensitivity of detecting sleep was 88.8%, specificity was 69.5%, and agreement was 84%. Sensitivity and agreement tended to go down with increasing SDB levels (from 91% to 85%, and 86% to 79%, respectively). Specificity was less affected by increasing SDB levels (ranged between 68% and 71%). Considering all subjects, aTST versus pTST was 690 ± 152 and 690 ± 154 minutes, respectively ($P > 0.05$). However, a Level 2 study[16] utilizing the same optimized device found no significant correlation between pTST and aTST. Bland-Altman comparison showed much scatter, with mean of the differences in TST = 12.17 ± 64.5 min. Another (Level 4b) study[30] using the same device found a good correlation between the arousal index estimated from a device using peripheral arterial tonometry changes to detect arousal and actigraphy to estimate sleep time, and the arousal index determined by conventional PSG methods ($r = 0.87$, $P < 0.0001$). In this study there was no report of actual TST or number of PAT arousals; only the ratio was reported. Therefore, the contribution of actigraphy to the reported correlation could not be evaluated.

Finally, two studies used actigraphy to estimate TST in patients with sleep disordered breathing without formal comparison to another measure of TST. Larkin et al (Level 4b)[31] found that mean TST correlated with changes in C-reactive protein in adolescents with sleep apnea. Noseda et al (Level 5a)[32] used leg actigraphy to measure treatment-induced changes in leg activity in patients with sleep disordered breathing, and did detect treatment effects, but the study was otherwise methodologically limited for estimating the utility of actigraphy.

3.1.4. Actigraphy is indicated as a method to characterize circadian rhythm patterns or sleep disturbances in individuals with insomnia, including insomnia associated with depression. (Option)

This is similar to the prior recommendation. There were two Level 5b studies[33,34] characterizing sleep patterns in individuals with complaints of insomnia. There were two Level 3[35,36] studies and one Level 4b[37] study indicating that actigraphy is a way to characterize sleep or circadian rhythms in patients with a depressive disorder.

3.1.5 Actigraphy is indicated as a way to determine circadian pattern and estimate average daily sleep time in individuals complaining of hypersomnia (Option).

There were no studies identified that compared actigraphy versus the clinical history plus sleep logs (or another reference standard) to estimate mean sleep time or sleep pattern when evaluating patients with hypersomnia as a complaint. One Level 3 study evaluated patients diagnosed with a variety of hypersomnia disorders, including narcolepsy, idiopathic hypersomnia, hypersomnia associated with psychiatric disorders, HIV-encephalopathy, brainstem stroke, periodic hypersomnia, postviral illness, and head trauma.[38] Actigraphy was used to determine the average daily sleep time over one week prior to evaluation with PSG and MSLT, and biochemical assessment. Actigraphy estimated mean sleep time varied between diagnostic groups, with patients with hypersomnia associated with psychiatric disorders sleeping longer on average ($P < 0.037$ by Wilcoxon rank sums method, our own analysis of their data). Actigraphically determined TST averaged ≥9 hours per day in 11 of 27 patients, including all but one patient with hypersomnia associated with psychiatric disorders, and none of the patients diagnosed with narcolepsy or idiopathic hypersomnia. The shortest mean aTST was 7.44 hours per day in the idiopathic hypersomnia group. The authors indicated that history plus the results of actigraphy, PSG, and MSLT contributed to the diagnosis of disorders of hypersomnolence, but the exact role of actigraphy in interpreting MSLT or assigning diagnoses was not described.

The complaint of sleepiness must be evaluated in the context of recent sleep duration and pattern before a judgment can be made as to the pathologic nature of the complaint. The guidelines developed for the MSLT[39] indicate that sleep logs may be obtained for 1 week prior to the PSG/MSLT to assess sleep-wake schedules and assist in interpretation of results, while the ICSD-2 indicates that "the sleep-wake schedule must have been standardized for at least seven days before the polysomnographic testing (and documented by sleep log or actigraphy)" in order to properly interpret an MSLT. However, some individuals, such as those with impaired cognition, literacy, or motivation may be unable to keep accurate sleep logs, and both over- and underreporting of total sleep time and pattern have been of concern. Therefore, the committee used the Rand/UCLA Appropriateness Method (described above) to determine expert consensus regarding this parameter on the indications for use of actigraphy in hypersomnia. There was agreement that actigraphy is an appropriate way to ensure stable sleep patterns and adequate sleep duration prior to PSG and MSLT.

3.2 Use of actigraphy in assessing the response to therapy of sleep disorders

3.2.1 Actigraphy is useful as an outcome measure in evaluating the response to treatment for circadian rhythm disorders. (Guideline)

This is the same as the recommendation in the previous practice parameters paper. Additional evidence shows that changes in actigraphy measures are in agreement with other outcome measures in the assessment of response to intervention in patients with circadian rhythm sleep disorders.

There were two additional Level 3 studies using actigraphy as an outcome measure in the treatment of jet lag[40,41] and one additional Level 3 study using actigraphy as an outcome measure in a study of shift work.[42]

3.2.2 Actigraphy is useful for evaluating the response to treatment for patients with insomnia, including insomnia associated with depressive disorders. (Guideline)

This is the same as the recommendation from the previous practice parameter paper. There were one additional Level 1,[43] two Level 2,[9,44] two Level 3,[45,46] and two Level 5b studies,[33,34] indicating that actigraphy is useful in detecting treatment response in people diagnosed with insomnia. In addition there were two Level 3[47,48] studies indicating that actigraphy is a useful adjunct in detecting treatment response in people diagnosed with disrupted sleep or circadian rhythms associated with a depressive disorder.

3.3 Use of actigraphy in special populations and special situations

3.3.1 Actigraphy is useful for characterizing and monitoring sleep and circadian rhythm patterns and to document treatment outcome (in terms of sleep patterns and circadian rhythms) among older adults living in the community, particularly when used in conjunction with other measures such as sleep diaries and/or caregiver observations. (Guideline)

This recommendation is a modification of the previous practice parameter paper. The evidence for use of actigraphy to characterize and monitor sleep and circadian rhythm patterns among older adults living in the community is based on two additional studies identified in the current review that addressed the use of actigraphy in normal older adults. There were one Level 2[49] and one Level 3[50] study using actigraphy to evaluate sleep and circadian rhythms in normal older people**.** In the Level 2 study by Ceolim et al[49] there were significant correlations ($P < 0.005$) between sleep log and actigraphic variables (e.g., TST) collected for 23 days in over 76% of a sample of healthy older people. In the Level 3 study of a sample of 103 community-dwelling older adults,[50] actigraphic measures correlated with subjective reports in subjects without sleep complaints but not in those complaining about their sleep. Although able to distinguish between noncomplaining good sleepers and complaining poor sleepers, actigraphy was not able to distinguish between other categories of sleepers in this sample. Results of this study provided evidence of actigraphy's ability to determine TST and sleep onset latency (in women only) for those not able to provide sleep diary information.

The evidence for use of actigraphy to document treatment outcome (in terms of sleep patterns and circadian rhythms) among older adults living in the community is based on two additional Level 3 studies.[51,52] In a placebo-controlled trial[51] of melatonin treatment in healthy older adults presenting either with or without sleep complaints, sleep diaries were used as the reference standard. There was little difference in subjective and actigraphically estimated sleep quality on either measure in either group as a result of melatonin treatment. In the other study,[52] both in-laboratory and at-home measures were taken to determine the effects of daytime naps on nocturnal sleep and performance. In the at-home condition, TST and sleep efficiency were consistent when compared between actigraphy and sleep log results**.**

3.3.2 Actigraphy is indicated for characterizing and monitoring sleep and circadian rhythm patterns and to document treatment outcome (in terms of sleep patterns and circadian rhythms) among older nursing home residents (in whom traditional sleep monitoring by polysomnography can be difficult to perform and/or interpret). (Guideline)

This is a modification of the recommendation of the previous practice parameter paper. The evidence for the use of actigraphy to characterize and monitor sleep and circadian rhythm patterns among older adults living in nursing homes is based on five additional studies in the nursing home setting. Two Level 3 studies,[53,54] two Level 4 studies,[55,56] and one Level 5b study[57] were identified. Several studies used observer ratings as the reference standard for comparison with actigraphy. One Level 3 study[53] found that although results were similar between nursing staff and actigraphy for some sleep measures, nursing staff noted less sleep disruption during the night (WASO) than was recorded by actigraphy. Another Level 3 study[54] was able to discriminate diagnostic subtypes among dementia patients according to patterns of activity and core body temperature rhythms. Two Level 4 studies examined patterns of rest/activity in relation to presence or absence or Level of dementia. A Level 4b study[55] found that actigraphic rest/activity patterns differentiated patients with mild dementia from those advanced to the moderate stage. Similarly, a Level 4a study[56] was able to distinguish demented from nondemented subjects on the basis of daytime and nocturnal activity levels. Further they found that functional ability was associated with diurnal patterns of activity.

The evidence for use of actigraphy to document treatment outcome (in terms of sleep patterns and circadian rhythms) among older nursing home residents is based on 13 additional treatment outcome studies, including two Level 2[17,58] and three Level 3 studies.[59-61] Furthermore, there were six Level 4[62-67] and two Level 5b[68,69] studies evaluating treatment outcomes in dementia or nursing home populations. One Level 2 study[58] tested the effects of withdrawal of antipsychotic medication on sleep/wake activity and on behavioral and psychological symptoms in nursing home residents.[58] Actigraphic results were compared with psychiatric inventory responses, and restlessness was significantly associated with mean 24-hr actigraphic measures of activity ($r = 0.60$, $P = 0.001$) and nocturnal sleep problems were significantly associated with nighttime activity levels. ($r = 0.60$, $P = 0.001$). In another Level 2 study[17] of a randomized controlled trial comparing the effects of two different doses of melatonin and placebo on sleep in Alzheimer disease patients found no significant differences on sleep outcome by actigraphy between treatment groups. However, a subset of seven subjects had simultaneous actigraphy

and PSG for a period of 18 days and the TST estimated by actigraphy correlated highly with PSG (r= 0.92, P <0.01). In addition, a Level 3 study[59] testing the effects of bright light in a nursing home sample found significant improvements in sleep time and wake time within nocturnal sleep according to actigraphy which paralleled nursing staff ratings.

3.3.3 Actigraphy is indicated for delineating sleep patterns, and to document treatment responses in normal infants and children (in whom traditional sleep monitoring by polysomnography can be difficult to perform and/or interpret), and in special pediatric populations. (Guideline)

This recommendation is a modification of the recommendation from the previous practice parameter paper.[1] This recommendation is based on 23 additional studies identified in the current review that addressed the use of actigraphy in children. There were a total of five Level 2 studies (no studies were identified as Level 1, due to the absence of information regarding blinding, as described above), seven Level 3 studies, nine Level 4 studies, and two Level 5 studies of actigraphy in pediatric populations. These studies included a range of age groups (infant through adolescent), as well as a number of different medical, psychiatric, and sleep disordered diagnostic groups, and used a variety of reference standards.

In terms of age groups, the largest numbers of studies (10) were focused on infants (typically between 6 and 12 months). One Level 2 study[70] compared a parent-report infant sleep questionnaire (Brief Infant Sleep Questionnaire – BISQ) with actigraphy and daily sleep logs to assess correspondence between measures, as well as to determine differences between a control and clinical sample of infants referred to a sleep clinic. Significant but moderate correlations were found between BISQ and actigraphic measures of sleep onset latency (SOL) (r = 0.54, P <0.001) and night wakings (r = 0.42, P <0.0001), with nocturnal sleep duration showing lower agreement (r = 0.23, P <0.05). In contrast, the most robust correlations found between actigraphy measures and the reference standard (daily sleep logs) were found for SOL (r = 0.96, P <0.0001) and nocturnal TST (r = 0.87, P <0.0001), rather than night wakings (r = 0.49, P <0.0001). There were also some significant systematic differences between actigraphic and sleep log measures, with actigraphy providing lower estimates of sleep duration and higher estimates of night wakings compared to sleep diaries. Only one actigraphic measure, number of night wakings, had a unique contribution in discriminating between the control and clinical samples (F=6.29, P <0.05).

A different reference standard, direct observation of infant behavioral states, was used in a Level 2 study using actigraphy in assessing sleep-wake rhythm and sleep structure in healthy 1, 3, and 6 month old infants.[71] The overall agreement between measures in scoring sleep and wake was satisfactory (between 87% and 95%) after 3 months of age, but agreement was less than 73% at 1 month. Reliable actigraphic distinction, however, between active and quiet sleep could not be made in any of the three age groups.

Healthy term 6-8 week old infants were also the subjects in a Level 3 study[72] which assessed the effects of infant massage on the development of circadian rhythms by comparing actigraphy and salivary melatonin levels; peaks of period activity were delayed in the intervention group compared to controls. Another Level 3 study[73] which longitudinally assessed the relationship between light exposure, sleep patterns, and crying in healthy 6-12 week old infants found overall consistency between actigraphic measures of nocturnal activity and parental reports of sleep. A third Level 3 study documented some differences in activity-rest cycles but not in other sleep parameters during the first week of life in infants grouped according to delivery mode (planned C-section, emergency Caesarian section, and normal spontaneous vaginal delivery).[74] One Level 4b study[75] found some significant differences (i.e., increased variability ultradian cycles, diurnal sleep duration) in actigraphically derived activity-rest behaviors between healthy pre-term and full-term infants, while another[76] Level 4b study used actigraphy to characterize inter-individual variability in activity-rest behavior and differences in sleep duration between pre- and full-term infants. Actigraphy was also used in a Level 4b study[77] to document a significant increase in nocturnal activity counts associated with rapid ascent to moderate altitudes in a groups of infants and young children (4-33 months), and in another Level 4b study[78] which examined the development of circadian rhythms in newborns by comparing sleep-wake patterns longitudinally in newborns and their mothers at 3, 6, 9, and 12 weeks. A Level 5 study[19] used actigraphy to determine sleeping position and measure sleep-wake patterns in healthy 34-42 week old infants. Finally, a Level 3 study[79] assessing differences in sleep patterns in *parents* of newborns, found that mothers had less actigraphically documented sleep at night and more during the day compared to fathers, that breastfeeding was associated with more WASO, and that working mothers had an average 6-7 minutes less sleep in 24 hours than nonworking mothers.

Older children and adolescents were subjects in several other studies. A Level 4b study[80] which assessed the ability of measures of emotional intensity (maternal rating, vagal functioning) to predict actigraphically determined sleep problems in healthy school-aged children, found that increased emotional intensity was correlated with reduced nocturnal sleep and increased night activity. A Level 2 study[81] examined the validity of a self-report adolescent sleep survey by comparing retrospective self-report estimates of sleep patterns (TST, bedtime, and waketime on weekends and weekdays) with sleep parameters measured by both actigraphy and sleep logs over a subsequent week. Survey-estimated school-night total sleep times and wake times did not differ from diary and actigraphy measures, although survey bedtimes were slightly earlier. On weekends, survey-reported sleep duration was about 30 minutes longer than estimated by sleep diaries (t = 4.26, P <0.001) and actigraphy (t = 5.25, P <0.001), and wake times were about 55 minutes longer. Overall, school- and weekend-night survey variables were significantly correlated with both diary and actigraphy variables, but the strength of the associations were consistently greater for school-night variables than for corresponding weekend-night variables. However, it should be noted that there was no attempt to directly compare actigraphy and the reference standard sleep log variables in this study; in fact, it was noted in the Methods section that the procedure ("Sadeh algorithm") used to analyze actigraphy "relies heavily upon the concurrent behavioral self-report obtained by the sleep diaries," and thus the two measures would be expected to be highly correlated.

Actigraphic measures of sleep were also used in studies of several pediatric patient populations with chronic medical conditions. One was a Level 2 study that primarily assessed the relationship between sleep disturbance and pulmonary function in a group of children with cystic fibrosis (CF) but also compared actigraphy

to parent- and self-report data in this population.[82] There was a significant correlation between sleep duration (the only parameter reported) as measured by actigraphy with sleep period reported by parents ($r = 0.79$, $P<0.0001$) and by children ($r = 0.71$, $P <0.0001$) in the control group, but not in the CF group ($r = 0.29$, $P = 0.06$; $r = 0.18$, $P = 0.2$, respectively). A Level 3 study[83] used actigraphy to confirm sleep instability, frequent microarousals, and increased daytime napping in a group of children with Smith-Magenis syndrome (a genetic syndrome frequently characterized by self-injury and sleep disturbances). Actigraphy was also used to measure sleep disturbance in a Level 4b study[84] of blind adolescents with and without optic nerve disease, which documented that greater wake time instability was associated with optic nerve disease.

In studies of children with psychiatric disorders, one Level 3 study[85] used actigraphy to study sleep patterns in children with ADHD with and without sleep problems compared to controls, and found significantly delayed sleep onset and offset in children with ADHD and insomnia, suggesting a circadian rhythm abnormality. A Level 4b[86] intervention study used actigraphy to document treatment response (decrease in mean nocturnal activity) to melatonin and rebound sleep disturbance following discontinuation in children with Asperger syndrome. Another Level 4b[35] study, which used actigraphy to evaluate locomotor activity and circadian rest-activity cycles in children with major depression compared to controls, found significant differences related to gender and age but not group assignment. Finally, a retrospective chart review (Level 5 study)[87] of children with ADHD referred to a sleep center showed a high incidence (94%) of sleep onset delay and high night-to-night variability in sleep patterns in the small percentage (16%) of subjects for whom actigraphy data was available.

There were also several studies which used actigraphy to assess sleep in children with sleep disorders. Agreement between periodic limb movement during sleep scored by actigraphy and those detected with anterior tibialis EMG was assessed in a Level 2 study of ninety-nine 4- to 12-year-old children.[88] It was concluded that this actigraphic measurement of PLMs in children was not sufficiently accurate to permit use in clinical settings. Specifically, actigraphy tended to overestimate PLMs compared to EMG, and, although the application of a correction factor based on average number of EMG-derived movement during arousals improved agreement between measures somewhat, different correction factors were required for each of the different diagnostic groups (SDB, primary snoring/normal, and periodic limb movement disorder), limiting its utility as a diagnostic measure. One Level 4b study[31] of adolescents with SDB found sleep duration was significantly negatively correlated with C-reactive protein, body mass index, and AHI.

Finally, one Level 2 study[89] compared actigraph placement (waist vs nondominant wrist) in estimating sleep duration in school-aged children. Although diurnal activity was lower with waist placement, the overall minute-by-minute agreement of sleep-wake states between placement sites was 92.5% (range 82.3%–97.7%), and nocturnal agreement was 95.6%. None of the mean sleep estimates (sleep duration, sleep latency, sleep percentage, sleep efficiency) were significantly affected by placement site, although there were some inter-individual differences in agreement (sleep duration and latency). Another Level 3 study[90] assessing compliance with imposed sleep schedules in the home setting in school-aged children demonstrated significant differences in actigraphically measured sleep according to condition.

4. RECOMMENDATIONS FOR FUTURE RESEARCH

4.1

Additional research is needed which compares results from different actigraphy devices and the variety of algorithms used to evaluate actigraphy data in order to further establish standards of actigraphy technology. Well designed studies using actigraphy should describe the device and the analysis algorithms used.

4.2

There is need for additional study addressing the reliability and validity of actigraphy compared to reference standards, such as polysomnography, and the circadian rhythms of basic physiologic functions, such as temperature, cortisol, and melatonin levels.

4.3

Further research is needed to establish standards for setting start and stop times of the sleep and wake periods when using actigraphy, including techniques such as event markers or sleep diaries, and other methods in the study of populations where these techniques may not be valid (e.g., dementia patients, nursing home setting). For example, difficulty in establishing a standard for setting start time is likely one factor contributing to the difficulty in correlating certain sleep variables (especially sleep onset latency) measured by actigraphy with findings from PSG.

4.4

Well-designed studies should include technical details related to the administration and scoring of actigraphy. In much of the existing literature, there is an inadequate description of whether visual inspection of data is performed, how missing data is handled, and other important decisions made in the analysis of actigraphy data. More research is needed to assess the reliability of actigraphy under various clinical circumstances, and to determine what parameters may be used to assess the quality of actigraphic data.

4.5

Further work is needed to clarify the relative and unique contributions of actigraphy, polysomnography and sleep logs in the diagnosis of sleep disorders and measurement of treatment effects. For example, besides estimates of wake and sleep times, there are various other data generated by commercially available analysis software, such as fragmentation index and movement index, for which clinical correlates are not well described.

4.6

The use of actigraphy in hypersomnia populations, especially as an adjunct to the Multiple Sleep Latency Test, should be tested to establish an evidence-based recommendation for the use of actigraphy in the clinical evaluation and management of hypersomnia.

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Actigraphy Evidence Table

Author/Year/Citation #	Actigraph Evid Level	Study Description	# of patients	# contr	% of males	Mean Age ± SD, (range)	Study Outcomes	Condition (diagnosis)	Device	Recording Time (day / hours)	Analysis Method	Algorithms	Standard compared with	Actigraphy Outcomes	Actigraphy Conclusions
{Aessi, 2005 #693}	4b	RCT of nonpharm intervention to improve abnormal sleep/wake patterns in nursing home residents	Enrolled:62 Completed:58	56	23%	87±9	There was a 46% decrease in observed daytime sleep from baseline to post-tx in the intervention group, with essentially no change in the controls. The duration of nighttime awakenings were slightly decreased; with no sig effects on % night sleep or # awakenings measured by actigraphy.	Elderly nursing home residents w/ abnormal sleep/wake patterns	Screen: Minimotionlogger, AMI Intervention: Actillume, AMI	Start: NS End: NS Duration: 72hrs	Actigraphy variables avg'ed over the 72hr period	Action3, AMI	None	Ability to detect treatment effect in a nursing home population. 1) There was a modest decrease in the duration of nighttime awakenings compared to controls (p = 0.042). 2) Actillume showed increase in daytime light levels in int group, but not in cntrl group	Useful for detection of treatment outcomes in residents of nursing homes
{Amin, 2005 #679}	2	Compared the sleep of healthy controls to that of stable children with CF to determine if pts with CF have lower sleep efficiency and if there is a relationship with pulmonary function and sleep disturbance	Enrolled: 93 Completed: 84	40	46.40%	P 11.9 ±2.8 (NS) C 12.0 ±2.8 (NS)	1. Children with CF had more frequent and longer awakenings than healthy children 2. Children with more severe pulmonary disease had more disturbed sleep	Cystic fibrosis	Am-Motion-logger	Start: NS End: NS Duration: 5 weekdays	NS	NS	Sleep Logs	Acti showed that sleep efficiency was reduced with more severe pulmonary disease. There was a significant correlation between acti measured sleep duration and both self (r = 0.71) and parental (r = 0.79) reports in the control, but not for the CF group (acti > questionnaire).	High correlation between acti and retrospective reports (both parental and from the child) in normals, but not patients with cystic fibrosis.
{Ancoli-Israel, 2003 #1359}	5b	Patients were randomly assigned by block stratification (morning, evening, or all-day agitation) to 1 of 3 treatment groups: AM (0930-1130 hrs) Bright, AM Dim Red or Evening (1730-1930 hrs) Bright Light.	Enroll: 92 Compl: 83 (Data available on 72)	NA	32%	82.3 +/- 7.6 (61 – 99 yrs)	Increased Bright Light exposure consolidates nighttime sleep by lengthening max sleep bouts across the night	Alzheimer's Disease CRSD's	Actillume recorder (AMI)	Start: NS End: NS Durat: 18 days (Baseline-3 days, light treatment -10 days, and post-tx f/u-5 days)	ACTION 3 software (AMI)	Day (Wake-up to Bedtime) Night (Bedtime to Wake-up time) Max and Mean minute-by-minute activity	Baseline/Post-Treatment Follow-up Dim Red Light	Acti used as sole outcome measure. No effect on "tradtional sleep measures". Noct sleep consolidation was improved w/tx and persisted across f/u after tx discont.	
{Ando, 2002 #999}	3	To examine the prevalence of circadian rhythm sleep disorders (by DSM-IV) in a representative population aged 40-64 yrs and compare objectively recorded sleep times of symptomatic subjects with the surveyed population.	Enroll: 417 Compl: 350	NA	45%	51 +/- 7 yrs [40 -64 yrs]	Prevalence of ASPS was 7.4% and DSPS was 3.1% by DSM-IV criteria (combination of both am and pm complaints). No signficant correlations were found comparing sleep complaints with objectively recording sleep timing.	DSPS or ASPS by DSM-IV criteria	Actillume (AMI)	Start: NS End: NS Durat: ~3 days	Sleep Onsets/ Offsets	Custom – (Jean-Louis et al, 2001, Physiol and Behav, 72:21-28)	Sleep Logs Subjective Measures	Average recorded bedtimes were 10 min later and wake times were 22 min later than reported by questionnaire (r = 0.75 and r = 0.71, respectively, for subjective vs. objective measures, p < 0.01).	Reasonable correlation between actigraphy and retrospective reports for bedtimes and wakетimes; the exact time was off by 10 to to 22 min, respectively. There was no correlation between sleep complaints and sleep timing.
{Armitage, 2004 #1094}	3	To evaluate the circadian rest-activity cycles and locomotor activity in children (8-12 yrs) and adolescents (13-17 yrs), w/ major depressive disorder (MDD) , stratified by sex and age/Tanner stage. A comparison group of age and sex matched healthy controls was included.	Enroll: 59 Compl: 59	41	53%-MDD Ps 51% - Normal Contrs	(8-17 yrs old for all 100 Ps/Contrs) 9.5 to 10.3 yrs= mean age range of pre-teens across group and sex 14.5-15.5yrs= mean age range of teens across group and sex	Adolescents w/ MDD had lower activity levels, damped circadian amplitude, lower total light exposure, and spent less time in BL compared to their age matched controls. Children w/ MDD had lower light exposure and also spent less time in BL, but only the depressed pre-teen girls had a damped circadian amplitude. Sex diffs were greater in the MDD group compared to the Contr group.	Children and Adolescents w/ MDD (DSM-IV)	Actiwatch-L (Mini)	Start: Noon End: 9am last AM Durat: 5-days (only 3-days of complete data for 5 Ss)	Mini software	Average activity count/min in the light vs dark pers; time series/Fourier-based spectral analysis	Sleep Logs Subjective Measures- Clinical Interviews, Questionnaires, various scales Med and Neuro/Physical Exam/Lab Tests	Acti monitoring revealed age, gender, and MDD related differences in activity levels during the day and night. Differences in amplitude of the circadian activity rhythm also detected.	Acti can be used to measure differences in day/night activity levels in children and adolescents.
{Asayama, 2003 #655}	4b	Double-blind, randomized allocation, controlled evaluation of the effects of melatonin (3 mg or placebo at 20:30 for 4 weeks) on the sleep/wake rhythm and cognitive and non-cognitive function in Alzheimer type dementia.	Enrolled: 11 Completed: 10	9	15%	79.2±6.4	Significantly prolonged sleep time and decreased activity level at night in the melatonin group.	Alzheimer type dementia	MiniML (AMI)		3 "serial" days out of 7 were used for analysis	Cole's	NA	Ability to detect treatment effect of melatonin on sleep time and night time acitivity in patients with PRAD	Useful for detection of treatment outcomes in special populations
{Baskett, 2003 #783}	3	Randomized, double blind, crossover study assessing sleep in problem and normal sleepers with 5mg melatonin, or matching placebo, taken at BT for 4 wk, separated by 4wk washout period	Enrolled: 20 Completed: 19	20 15	32%	71.7 ± 4.9	Melatonin taken at bedtime did not improve sleep in elderly with sleep maintenance problems or normal sleepers	Age ≥ 65 with age-related sleep maintencance problem or normal sleep	Actiwatch Cambridge Neurotech	Start: NS End: NS Duration: 5 days	NS	Sleepwatch software	Sleep Logs	Overall, there was little difference between subjective and actigraphic measures of sleep quality (latency, duration, efficiency and number of awakenings) in this well designed study. Aside from the number of awakenings (decreased by w/melatonin in normals by actigraphy but not logs), neither measure showed improvements in sleep following tx.	Consistent results for sleep quality between actigraphy and sleep logs (both no change) in healthy older adults (both with and without sleep maintenance problems)
{Bassetti, 2003 #760}	3	To test whether CSF hypocretin-1 levels were low in patients with narcolepsy w/out cataplexy and to test if a multi-modal approach would increase diagnostic specificity in patients with hypersomnia (of primarily neurological origin)	Enroll:27 Compl:27	0	55.50%	38 (16-53)	1. Hypocretin-1 levels were detectible in 24/27 patients, including 2 patients with narcolepsy 2. REM related symptoms were common and not specific to patients with narcolepsy	Hypersomnia, various types	Am, Motion-logger with light sensor	Start:NS End:NS Durat: 1 week	NS	NS	PSG Subjective Measures	Evaluated as one component of multi-modal dx of hypersomnia (with specificities ranging from 30 to 78%) Actigraphy records showed increased sleep time (>9 hr/day) in 11 of 27 patients, including 5/6 patients with hypersomnia associated with a psych disorder	Actigraphy identified 40% of patients diagnosed with narcolepsy by sleep > 9 h. May be useful as one component of a multi model dx of hypersomnia.
{Beaumont, 2004 #1358}	3	Double-blind, randomized , placebo-controlled, parallel groups study of slow-release Caffeine, Melatonin, or placebo for jet lag (7 time-zone eastbound flight) and sleep deprivation (33-hrs) over a 10-day/9-night f/u period.	Healthy Volunteers Enroll: 27 Compl: 27	NA	67%	35.3 +/- 8.1 (19-47 yrs)	Slow-Release Caffeine alleviated daytime sleepiness but exerted negative effects on sleep. By contrast, Melatonin improved sleep but did not objectively mitigate daytime sleepiness.	Jet lag/Sleep Deprivation	Piezoelectric accelerometer (Gaehwiler Electronic, sensitivity: 0.1G, sampling rate: 8 Hz, band-pass filter:0.25-3 Hz)	Start:NS End:NS Durat: 17-days (6-Baseline, 24-hr flight day, 10-Recovery)	NS	Custom designed: movements with a force >0.1G averaged across Morning, Afternoon, and Evening/Night, time segments.	PSG – both in-lab & portable Sleep Logs Subjective Measures Placebo	Significant differences in the 24-hr activity profile occurred between drug (caffeine/melatonin) and baseline conditions. Daytime activity was higher on slow-release caffeine, consistent w/decrease in objective and subjective sleepiness. Indications of impaired sleep w/ SRC; but there was no sleep fragmentation w/actigraphy.	Increased activity levels during the daytime were consistent with decreases in objective and subjective sleepiness. Actigraphy not sensitive to changes in sleep following slow release caffeine.
{Benson, 2004 #723}	4a	To determine if there were any differences in the performance of two brands of actigraphs when they were used in a naturalistic setting (home environment)	Enroll:20 Compl:20	NS	35%	35.35 ±11.8 (24-64)	At medium sensitivity, there are no significant differences between TST, WASO, and SE recorded by the two brands of actigraphs		MM Actiwatch-L and Am Mini-Motionlogger Basic	Start: End: Durat: 2 overnight within a 3-weel period	Used the software that came with each device	NS	Algorithms/Devices	1.When actiwatch was configured at medium sensitivity, results similar to motionloger 2. At low sensitivity (actiwatch), recorded less WASO than motionligger. 3. At high sensitivity (actiwatch), were significant differences in TST, WASO, and SE	These two commercially available monitors are similar, particularly with a medium sensitivity setting for the actiwatch. Detection of wake depends on the sensitivity setting of the activity monitor.
{Borges, 2003 #777}	3	To assess the impact of a 12-hr fixed night shift followed by 36-hrs off-time, on the sleep-wake cycle, sleep duration, self-perceived sleep quality, and work-time alertness, in nurses.	Enroll: 20 Compl: 20	NA	15%	34.9 +/- 7.5 yrs	Self-rated sleep quality was best for nocturnal sleep during the rest day off (p<.0001) followed by sleep during the 1st night after night work. Despite napping during the night shift, self-perceived alertness decr w/ the passage of time across night work (p<.0001), with the sleepiest period occurring betw the 7th and 10th hrs of the shift.	Night Shift Workers (Nurses)	Actigraph (AMI)	Start: NS End: NS Durat: 15-days	Actionwin Software (AMI)	Cole-Kripke algorithm (Cole et al, 1990, Sleep Res, 19:364-67)	24-hr Actigraphy Sleep Logs Subjective Measures- Questionnaires, various scales	Wrist actigraphy showed that all nurses slept at least 1hr during 2, of the 7-8, work nights across the 15-day study period (even against hosp regs). Duration of daytime sleep was shorter than nocturnal sleep after the end of the night shift (p<.0001). Impaired diurnal sleep quality was consistent with self-reports.	Actigraphy used to assess sleep timing and duration across the day and night in night-shift workers. Shorter sleep times were consistent with self-reports of poor sleep quality.
{Boulos, 2002 #796}	3	A field study to evaluate the efficacy of a bright light treatment (head-mounted visor) for jet lag following a westward flight across 6 time zones.	Enroll: 20 – Normal Ss Compl: 20	NA	40%	21-34 yrs old	The salivary DLMO (dim-light melatonin onset) resulted in a larger (about an hour) phase delay in the bright light compared to the dim light condition. There was no corresponding improvement in sleep, performance, or subjective ratings of jet lag symptoms.	Jet lag - Normals	Actiwatch-L (Mini-m)	Start: NS End: NS Durat: 17-days	Actiware-Sleep Software	Sleep vs Wakefulness – med sensitivity threshold Act count of 40; <40=Sleep; =/>40=Wake	Sleep Logs (preceding flight only) Subjective Measures Dim red light (10 lux) - Control	Group diff in DLMO but not acti w/tx. There was a group by night interaction for both PSG-SE% and activity level. Sleep questionnaire items did not show any diffs.	Changes in mean activity level were consistent w/changes in PSG-SE% following transmeridian travel in normal sleepers, but acti sleep parameters were not. Group diff in phase shifts of DLMO were not accompanied by changes in acti measures.
{Carney, 2004 #641}	3	To determine if students who were told the actigraph would be used to monitor adherence would be more likely to adhere to sleep hygiene protocols than students who were not told that adherence would be monitored by actigraphy.	Enroll:68 Compl:49	37	25%	Treatment group 20.4 ± 1.47 Control group 19.9 ± 2.17	1. Although sleep diaries showed that both groups of students followed study protocols, students told of monitoring (wearing actigraphs) were more likely to follow study protocols that students not being monitored. 2. Students who did not wear actigraphs went to bed an hour later than reported in their diaries and an hour later than required by study protocols	NA	ActiTrack 3.15C (IM Systems Inc)	Start: End: Durat: 48 hours	software	Visual determination of bedtime and arise times	Sleep Logs	Students wearing an actigraphy were more likely to adhere to study protocols and report sleep times accurately in their diaries than those who were not wearing actigraphs.	Acti is useful to monitor compliance to scheduled bedtime and wakeтime. Compliance to schedules and diaries is greater if subjects are told that they are being monitored by the actigraph.
{Carvalho Bos, 2003 #1357}	4b	Three field studies were designed to determine whether 24-hr activity records can be used to estimate the sleep and circadian system disruption caused by shift work or time-zone transitions and the process of adjustment. Studies 1 and 2 served as validity pilots for Study 3.	Enroll: Study 1: 8 pilots; Study 2: 12 travelers; Study 3: 117 pilots Compl: Study 1:7; Study 2:12; Study 3:117	Only Study 2: 15 Normals	Study 1: NS Study 2: (22-58 yrs) Study 3: NS	Study 1: NS Study 2: 67% Study 3: NS	Objective estimates of the disruption to the rest-activity cycle and the circadian system in the field can be obtained by an appropriate analysis of the 24-hour actigraphy record in shift work and time-zone transitions.	Shift Workers/Jet Lag	Actimeter (Cambridge Neurotechnology, UK)	Start: NS End: NS Durat: Study 1: 2-3 mos; Study 2: 4days; Study 3: 4-5 days	Custom	Custom	Algorithms/Devices	Actigraphy results moved in the predicted direction for disruption of sleep caused by shift-work or changes in the sleep/wake rhythm following travel across multiple time zones.	Actigraphy data can be used in field studies as a partial substitute for "gold standard" markers of sleep and the body clock, e.g. PSG, core temperature, and melatonin. The authors note that comparisons of custom activity algorithms with established markers of sleep and the body clock are necessary.
{Ceolim, 2000 #1145}	2	The study aimed to examine the sleep/wake cycle across 3 consecutive weeks in healthy elderly.	Enroll:61 Compl:23 Note: 61 volunteered for study, and 23 were selected based on entry criteria (see notes)	ns	35%	70.2 ± 3.6 (65-76)	An association was found between longer duration of physical exercise and greater strength of semicircadian component of the sleep/wake cycle in this sample of healthy, active elderly. Also, individuals that chose earlier times for exercising showed greater exposure to bright light during the day, and reported better sleep quality.	None	Actillume (AMI)	Start: End: Durat: reportedly 23 consecutive days	For "most" variables, authors found significant correlations between actigraphy and sleep log data (p<.05); and only those variables for which correlations between actigraphy and sleep logs had sig level of p<.005 were used (however, the variables were not specified or listed).	Action3 v3.21	Sleep Logs	Only sleep log variables that had a significant correlation with acti at least 74% of subjects were reported (Table 5). These included bedtime, lights out, sleep onset, waking time, total bed time, TST, and sleep efficiency.Sleep log variables that were not associated with acti were SOL, sleep interruptions, 24 h TST, and the timing, duration, and number of naps during the day.	Acti was used to validate the sleep log data. With the exception of SOL, nighttime sleep parameters showed significant correlations in at least 76% of subjects.

Author/Year/Citation #	Actigraph Evid Level	Study Description	# of patients	# contr	% of males	Mean Age ± SD, (range)	Study Outcomes	Condition (diagnosis)	Device	Recording Time (day / hours)	Analysis Method	Algorithms	Standard compared with	Actigraphy Outcomes	Actigraphy Conclusions
{Coffield, 2004 #712}	3	Actigraphy was used to validate/track sleep improvement at discharge compared to admission for a group of consecutively admitted patients w/ MDD. Comparison to a control group was included.	Enroll: 33 Compl: 18	21- neither age, nor sex matched	61%-MDD Ps 29%-Contr Ss (sign diff)	30 +/- 11.7yrs-MDD Ps 40 +/- 11.3yrs-Contr Ss (sign diff)	Depression Scales confirmed clinical improvement post-tx prior to the 2nd week of Actigraphy and sleep logs. SO Lat, # of nighttime awakenings, mins awake after SO, and Sleep Eff%, improved sign from pre- to post-tx actigraphy weeks in the MDD Ps. SO Lat and # of nighttime awakenings were no longer sign diff betw groups during the post-tx actigraphy week. By contrast, sign diffs continued to exist betw MDD Ps and Contr Ss for mins awake after SO and Sleep Eff% during post-tx actigraphy.	Inpatients w/ Major Depressive Disorder (MDD) by DSM-IV	MotionLogger Actigraph (AMI)	Start: NS End: NS Durat: 7 days x 2 (variable period betw 2 sets of Actigraphy in Ps vs Contr Ss)	Action-3 Software (AMI)	Zero-Crossing Mode; Cole-Kripke Scoring algorithm (Cole et al, 1992, Sleep, 5:461-9.	Sleep Logs Subjective Measures – Psycholog testing, Clinical Interviews, various Scales	While post-tx Actigraphy sleep mins were sign corr w/ pre-tx actigraphy values, sleep log reported sleep mins were not in MDD Ps. Sleep log estimates of TST in MDD Ps were consistently greater (13.3-mins at pre-tx; 13-mins at post-tx) than estimated by Actigraphy (p<.001). Sleep logs in MDD Ps overestimated sleep by ~90-mins/week compared to actigraphy .	
{Crabtree, 2003 #757}	5a	A restrospective chart review of children with ADHD over a 2-yr period referred to a sleep center was carried out to determine whether they might represent a subset, different from the ADHD children presenting to pediatric, neurology or psychiatric clinics.	Enroll: 97 Compl: only 16 underwent Actigraphy	NA	94% - for the Actigraphy group 77% - for the entire group	7.9 +/-2.8 yrs (5-15 years) of those undergoing Actigraphy 8.3 +/-3.0 yrs (3-18 yrs) for the entire group	The high prevalence of subjective sleep complaints from the parents of ADHD children (presenting to a pediatric sleep center) is only verified by objective sleep assessments (PSG or 24-hr Actigraphy) in a small proportion of cases. Objective sleep assessments are most notable for the high, nocturnal intersubject and intrasubject variability in sleep structure and pattern.	CRSD's in Pediatric ADHD	Actiwatch-L (Mini)	Start: NS End: NS Durat: 14 days	NS	NS	none	16 of the children, suspected of having sleep/wake cycle disorder, were monitored by actigraphy. A 94% incidence of delayed sleep onset. High child and night-to-night variability in sleep was present across the 14-day monitoring period.	
{Currie, 2004 #637}	2	The study evaluated whether or not there was agreement between subjective, objective and collateral (e.g., spouse/sol/roommate) ratings of insomnia severity in post-withdrawal recovering alcoholics	Enroll:56 Compl:56	0	66%	42.2 ± 10.3 years	1. Average internal consistency between sleep log and actigraphy across 7 nights was 0.91 and 0.85 respectively 2. Scores between patient and collateral raters showed little concordance	Post withdrawal recovering alcoholics	Mini-motion logger (Am)	Start: End: Durat:7 nights	Software by Amb Monitoring based on algorithm by Cole et al (1992)	NA	Sleep Logs Subjective Measures	Sleep logs and actigraphy were significantly correlated for SOL (r = 0.64) and TST (r = 0.46). Estimates of sleet latency were longer for sleep logs than actigraphy, the average disagreement in TST was 55.5 minutes. SEF and WASO were not correlated.	Authors summary - Self-reported sleep revealed a greater severity of symptoms than either collateral reports or actigraphy, agreement between logs and actigraphy were comparable when averaged over days, but the nightly concordance was poor to moderately good.
{Currie, 2004 #645}	5b	RCT testing 2 different treatments (cognitive behavioral or self-help with telephone support) compared to placebo (wait-list control) in abstinent alcoholics with disturbed sleep	Enroll:20 20 Compl:15 17 Entire: 10 9 CBT S-H	20 17	70% 9	43.3 ±10.9 (18-70)	Improved subjective sleep measures with either treatment at post-treatment assessment	Abstinent alchoholics with sleep problems	Mini-motionlogger (AM)	Start: End: Durat:7 days	NS	NS	Sleep Logs Subjective Measures	1. Subjective improvements in sleep quality were not mirrored in the mean activity level, no other actigraphy parameters were reported. 2. There were no differences in actigraphically recorded mean activity levels from the baseline period to end of the study.	Activity counts (without sleep analysis software) are not comparable to subjective measures of sleep quality
{Daurat, 2004 #836}	3	A field study to describe the individual diffs in the adopted sleep strategy of a group of intensive care nurses alternating months on 12-hr Day shifts vs 12-hr Night Shifts. The focus was on sleep behaviors around the Night Shifts w/ nurses who napped during the shift vs those who did not. Day Shift, days off served as a Baseline cond.		NA	12%	29.25 +/- 3.4(SE) yrs-Night-Nappers 35.25 +/- 3.3(SE) yrs-Non-night Nappers	Half (4 of 8) of the nurses chose to take naps in 75% of their night shifts. Sleep length was sign reduced during night work when compared w/ days off, the result being nap behavior during both day work and night work. Non-night Nappers had long daytime sleep periods and took "preventive" naps in anticipation of sleepiness during night work, but their readjustment to day schedules was assoc w/ complaints of poor sleep quality and their diurnal activity levels were reduced below that of their night work shifts.	Night Shift Workers (Nurses)	Actiwatch (Cambridge Neurotechnology)	Start: NS End: NS Durat: 1-month	Actisom Software (Cambridge, Neurotechnology	Sleep/Nap duration=1st no-movement epoch after 5-mins immobility from LO and last no-movement epoch preceding continuous activity	24-hr Actigraphy Sleep/Nap Logs Subjective Measures – Questionnaires, various scales	Blind, prospective comparison to reference standard The activity index was higher for nighttime sleep on days off for both the day and night shifts (i.e. nighttime sleep was more fragmented than daytime sleep). Mean activity level was lower on the days off during a night shift and was sign lower compared to when on duty. For non-night nappers, their activity level during the night shift was higher compared to the night nappers who had lower activity levels when on duty compared to their days off.	
{De Leersnyder, 2001 #1143}	3	To determine the circadian rhythm of melatonin in the Smith-Magenis syndrome (SMS) known to cause sleep disturbances and behavioral problems.	Enroll: 20 Compl: 8 completed Actigraphy	30– for entire study For the 24-hr PSG, hormone assays - 15 kids/adoles hosp for idiopathic small stature, but otherwise healthy	55% of SMS group 62% of hosp SMS patients Controls – NS	All SMS Ps: 4-17 yrs 8 hosp SMS Ps: 4-17 yrs Controls – "Age-matched"	All children/adolescents with SMS had a night/day inversion of their circadian rhythm of melatonin compared to controls. Behavioral tantrums correlated with the melatonin rise and may have reflected a struggle against sleep.	CRSD's in Pediatric SMS	Actiwatch-score (Cambridge, Neurotechnology	Start: NS End: NS Durat: 8-14 days	Ave. Activity Offset and Onset	Actiwatch Software Programs	24-hr portable PSG (Oxford Medilog 90000 Sleep Logs Subjective Measures	"Actigraphy in the 8 hosp children correlated with sleep diaries and confirmed instability of sleep, frequent microarousals, and naps during the day (Fig 1)," p113. Naps and sleep attacks occurred in SMS when melatonin peaked at midday and in the evening, during the evening meal.	Acti consistent with parental logs of sleep disruption and with PSG for frequent arousals and a reduced duration of sleep relative to controls.
{de Souza, 2003 #782}	1	To evaluate the concordance between PSG and two algorithms for scoring actigraphy recordings (1. Cole's, and 2. Sadeh's,	Enroll:21 Compl:21	NA	33%	NS	See actigraphy outcomes	NA	Am; Mini-Motionlogger Basic 32 C	Start:NS End:NS Durat:NS	Recordings scored as wake vrs sleep, then each one minute epoch compared	1. Coles' algorithm (Action 3, vrs 3.15 AMI) 2. Sadeh's algorithm (Action for Windows vrs 1.05 AMI)	PSG Algorithms	1. 91% of all epochs identified as sleep on PSG were correctly identified by both algorithms 2. Actigraphy systematically overestimated sleep latency, TST, and sleep efficiency while it underestimated intermittent awakenings	High sensitivity for identification of sleep > 97%, but low specificity for identification of intermittent wake periods < 44%.
{Denise, 2003 #780}	4b	Double-blind cross-over study evaluating the effects of a single dose of zolpidem, zopiclone, flunitrazepam, and placebo on night-time motor activity	Enroll:33 Compl:33	NA	63.60%	27.5 (20-67)	1. All three drugs significantly reduced activity level and movement time on treatment night compared to placebo. 2 Mean duration of uninterrupted immobility was also increased by hypnotics compared to placebo. 3. Increased activity on first or second post-drug night with zolpidem and soplicone, respectively.	NA	Gaehwiler Electronic	Start:when ss took sleeper at night End: end of 1st night for 16 ss, end of 3rd night for 17 ss Durat: variable	1. Mean activity count 2. movement index 3. duration of uninterupted immobility periods as described in Middlekoop et al 1993	Start and end of sleep period determined by smoothing.	None	Differences in activity level, uninterrupted mobility, and movement time distinguished between drug and non-drug nights	Changes in motor activity can be detected by activity monitors
{Dowling, 2005 #685}	4b	The goal of this study was to test the effectiveness of morning bright light therapy in reducing rest-activity (circadian) disruption in institutionalized patients with severe AD. Authors state it was a randomized, placebo-controlled trial of usual light compared to bright light therapy.	Enroll: Compl:29	17	22%	84 ± 10 (60-98) For entire sample (n=46); Age not reported by group	Morning bright light exposure protocol did not induce an overall improvement in measures of sleep or of rest-activity rhythm	NINCDS-ADRDA Alzheimer Disease criteria	Actiwatch (MM)	Start:ns End:ns Durat:6 dys/7nts at baseline; 5dys & nights during last week of intervention	Primary outcome variables were SE, sleep time, wake time, and #wake.	Actiware Sleep Version 3.2 program	None	In a subgroup of the subjects who had desynchronized timing of rest-activity rhythm at baseline (defined as those who experienced their 10 most active hrs during typical sleep hours), sleep efficiency, night sleep and wake times were all improved at the end of the intervention.	Outcome measure for therapy in patients w/ severe AD
{Edinger, 2004 #711}	2	To determine if any of several devices (actigraphy, REM view sleep assessment device, and sleep logs provide accurate assessments of common sleep parameters when compared to PSG recordings	Enroll:38 Compl:33		90%	58.6 ±13.5	All devices tested differed from PSG on at least some variable	All patients had complaints of insomnia; however, at least 14 of the participants also had other sleep disorders ee.g., OSA (n=10), PLMS (n=3), and hypnotic dependant sleep disorder (n=1).	MM, Actiwatch	Start:NS End:NS Durat: I night	NS	NS	PSG Devices	Actigraphy differed from PSG for TST, WASO, TWT and sleep efficiency. Time in bed and SOL were similar for acti and PSG, and were more highly correlated than for sleep logs.	For TIB and SOL, acti did not differ from PSG and the correlation between logs and PSG was significantly lower than between acti and PSG. Acti measures of TST, WASO, TWT and sleep efficiency differed from PSG in a population with differing sleep disorders.
{Elbaz, 2002 #802}	1	Compared AHI based on acitgraphic estimate of TST with AHI based on PSG	Enroll: 20 Complete:20	NA	75%	52±15	Correlaton of actigraphic AHI with PSG-AHI was good (r=0.976, p<0.0001). Bland-Altman comparison showed best accuracy at AHI<25. Only one patient was over-classified (and none underclassified) as to OSA severity using the acti-AHI measure. Sensitivity for acti AHI in determining the presence of severe OSA (=psg AHI>=30) was sensitivity 88%, specificity 92.5%.	PSG confirmed OSA	Actiwatch	Start: ns End:ns Durat: 1 night	>40 movements/epoch	Sleepwatch	PSG	The Pearson correlation coefficient between the polygraphyderived total sleep time and actimetry-derived total sleep time was 0.74, p<0.0001.	actigraphy combined with standard measures of respiratory parameters may assist in the assessment of sleep disordered breathing severity.
{El-Sheikh, 2005 #697}	4b	To examine how well children's emotional intensity (scale ratings by mother) and vagal functioning during a baseline and a RT task predict sleep problems (actigraphy) in healthy, elementary school-aged children.	Enroll: 41 Compl: 41	NA	56%	10.06 +/-1.74 yrs (6-13 years)	Incr Emotional intensity was predictive of a reduced amount of sleep and incr night activity. Reduced vagal regulation (lower levels of RSA suppression to the RT task) predicted incr sleep probs by both subjective scales/logs and actigraphy.	Healthy Children	Actiwatch-64 (Mini	Start: Bedtime End: AM Rise-time Durat: 4 nights	Actiwatch-Score Software	Medium Sens.=Activity count of 40; Act<40=Sleep w/ weighting of adjacent epochs, Act>=40=Wake	Sleep Logs Subjective Measures: various scales	Partial correlations (controlling for demographic variables) between acti and overall SHS sleep/wake problems scale were not significant. The factor of sleep dissatisfaction was moderately correlated with sleep time, sleep efficiency and total activity.	Not a good association between acti and the sleep habits survey in healthy children.
{Fallone, 2002 #794}	3	To determine if school aged children would comply with two experimental manipulations in their sleep time (sleep restriction and an optimized sleep condition) in a home setting	Enroll:84 Compl:78	0	52.60%	10.2 (6.5-12.9 years)	The majority of children aged 6-12 complied were successful in following experimental protocols in a home setting (actigraphy recordings showed significant differences in their sleep times during the three conditions)	NA	Am, Mini-motionlogger	Start:NS End:NS Durat: averaged 11 24-hour periods/child during experimental portion of study		"our standardized method that uses a validated algorithm" then cites Sadeh et al, 1994	Sleep Logs	Successfully recorded acti for 72 of 84 children. Differences for bed time, sleep period, gender, and the experimental conditions were observed.	Acti can be used to measure adherence to a sleep schedule in children
{Ferber, 2002 #790}	3	To determine if massage therapy would serve as a time cue and enhance the development of circadian rhythms in infants.	Enroll:26 Compl:21	8	NS	All infants were studied at 6 and 8 weeks of age	Nocturnal melatonin peaks at 8 weeks were higher in infants who had received daily massages, suggesting that daily massage functioned as a time cue	Healthy infants	Somniter (Neurim Pharmaceutics)	Start:NS End:NS Durat: 20 hrs	NS	NS	Melatonin Levels	Periods of peak activity were delayed in treated infants at 8 weeks of age (3 am to 7am vrs 11 pm to 3 am in control infants). Nocturnal melatonin levels were also higher with massage therapy.	Acti can detect changes in circadian activity rhythms in infants.
{Fetveit, 2002 #806}	3	Study compared nurse observations of sleep/wake patterns in long-term nursing home residents to actigraphy recordings	Enroll:31 Compl:29	NA	13.80%	85.4 ± 7.2 (72-100)	Both nurse observations and actigraphy recordings showed disturbed nocturnal sleep, with the majority of patients having sleep efficiencies < 85%	Elderly, long-term nursing home residents, most with dementia	Cambridge Neurotechnology-actiwatch	Start:NS End:NS Durat:14 days	NS	NS	Caregiver report	Both measures showed disturrbed nocturnal sleep. Nursing staff observations of sleep onset latency and early morning awakenings were consistent with actigraph. Actigraphy recordings showed more nocturnal awakenings than nurse observations	Caregiver reports and actigraphy data were similar for sleep onset and offset, but actigraphy showed more WASO than nurse observations.

Author/Year/Citation #	Actigraph Evid Level	Study Description	# of patients	# contr	% of males	Mean Age ± SD, (range)	Study Outcomes	Condition (diagnosis)	Device	Recording Time (day / hours)	Analysis Method	Algorithms	Standard compared with	Actigraphy Outcomes	Actigraphy Conclusions
{Fetveit, 2003 #1355}	3	This study evaluates the effects of bright light therapy in demented nursing home patients with sleep disturbances. Open, nonrandomized study where participants served as their own controls.	Enroll:18 Compl:11	ns	9%	86.1± 8.9 (71-101)	Sleep improved substantially with bright light exposure (in 6 out of 7 actigraphically measured sleep parameters). Waking time within nighttime sleep was reduced by nearly 2 hours; sleep efficiency improved from 73% to 86% (p=.006); sleep onset latency was reduced by 1 hour.	Sleep disturbance defined as actigraphically measured SE<85%	Actiwatch (Cambridge)	Start: End: Durat: 3 2-week periods (baseline, pre-tx, tx)	Days 8-14 from pre-treatment period were compared with days 8-14 of the treatment period. Nurse staff observations used to help determine bedtime and uptime.	Actiwatch software	Caregiver report	Acti and nurse report both showed improvements in sleep in this pre-post intervention trial. 6 of 7 acti sleep parameters improved, including sleep efficiency, SOL, and total wake time. Bright light had significant effect on reduction of mesor (from 45.1 to 25.1; p=.0003); nonsignificant increase on the light/dark ratio (p=.097); and no significant change in acrophase.	Acti used to measure treatment outcome in demented nursing home patients with sleep disturbances. Authors created their own 5-item behavioral sleep observation scale for this study, and the results were similar to that found for the actigraphically measured sleep parameters.
{Fetveit, 2004 #1356}	4b	This study examined the longer-term effects of a two-week course of bright light therapy in demented nursing home patients with sleep disturbances. Open, nonrandomized study where participants served as their own controls.	Enroll:18 Compl:11	NS	9%	86.1± 8.9 (71-101)	During the 16-week post-treatment period, actigraphic measures gradually returned to pretreatment levels; after 16 weeks there were no significant differences from pretreatment for any variable	Sleep disturbance defined as actigraphically measured SE<85%	Actiwatch (Cambridge)	Start: End: Durat: Original study had 3 2-week periods (baseline, pretx, tx); this study ADDED 4 monthly post-treatment periods (each period = 7 consecutive days).	Days 8-14 from pre-treatment period were compared with days 8-14 of the treatment period. Nurse staff observations used to help determine bedtime and uptime.	Actigraphy Sleep Analysis 98, v4.13	Subjective Measures	Treatment improved acti measures of sleep efficiency, and reduced total wake time, SOL and early morning awakening. Bright light had significant effect on reduction of mesor (from 45.1 to 25.1; p=.0003); nonsignificant increase on the light/dark ratio (p=.097); and no significant change in acrophase.	Acti used to measure treatment outcome in demented nursing home patients with sleep disturbances.
{Fontana Gasio, 2003 #873}	4a	This study investigated whether low intensity dawn-dusk simulation (DDS), a "naturalistic" form of light therapy designed to embed sleep in its accustomed phase, could improve the disturbed circadian rest-activity cycle or nocturnal sleep in dementia. Design was a randomized trial	Intervention: DDS Enroll: Compl:9 7 pts dropped out, though group assignment not reported	Control: 'placebo' dim red light 4	8%	Int: 86.8 ± 4.8 Cntrl: 83 ± 5.2	While there were no differences between groups on clinical or cognitive status, nor on modification of circadian stability or amplitude characteristics of the rest-activity cycle, there were two sleep changes in the DDS group compared to dim red light group: 1) main sleep episode was 1:14h earlier during treatment (p=0.03) compared with before and after DDS and 2) actigraphy-measured sleep variables showed that the DDS group had shorted sleep latency, longer sleep duration, more nocturnal immobility, and less nocturnal activity than the dim red light group.	Dementia diagnosis (measured by MMSE) AND nurse-reported sleep disturbance	Actiwatch (Cambridge)	Start: End: Durat: 3 wks each during baseline, treatment, and follow-up	Missing activity or light data were replaced with the average of the mean of the 3 previous days at that time of the day	Actiwatch Sleep Analysis 98 v4.07	None		
{Gagnadoux, 2004 #732}	1	Study I Blinded comparison of TST estimated by PSG vs. acti in pts with clinical suspicion of OSAs. Study II sought to compare the TST measured by actigraphy with CPAP use periods.	Enroll: I:24; II: 28 Compl:	I: NA II: NA	I: 63% II: 93%	I: 50±16 II: 56±11	II: Estimated sleep time under nCPAP was 82% (ranged 41%-100%); nCPAP adherence and estimated TST (ie, amount of sleep measured by actigraphy while CPAP was used) correlation = 0.80 (p<.001). Marked individual differences seen in CPAP use and sleep measured by actigraphy, with much sleep without CPAP and much CPAP use while awake.	SDB via PSG	Actiwatch	Start: I:BT; II End: I:UT; II: Durat: I:1night; II:	Default medium sensitivity; integrated activity count><40 per epoch	Sleepwatch software (Cambridge Neurotech)	PSG (Study I)	Correlation of r=.90 b/w aTST (325 ±88) and pTST (328 ±82); 95% CI TST difference was 2.5 min (-73.1 to 78.1) b/w aTST and pTST, The diff b/w aTST and pTST exceeded 1 h in 3 patients	High correlation between PSG and acti for TST. Actigraphy may be useful for assessing improvements in sleep with treatment.
{Gay, 2004 #746}	3	To describe the sleep and fatigue patterns for both parents in late pregnancy and again in the early postpartum period using both objective (actigraphy) and subjective (logs, scales, questionnaires) measures to estimate sleep. The influence of work status and breastfeeding on new parents' sleep and fatigue was included.	Enroll: 154 (77 couples) Compl: 144 (72 couples)	NA	50%	32.1 +/- 5.1yrs (20-43yrs)-Moms 34.6 +/- 6.3yrs (22-53yrs)-Dads	Both moms and dads had comparable amounts of sleep during final mo of preganancy. However, from pregnancy to postpartum, moms lost an ave of 41.2-mins of nighttime sleep compared to only 15.8-mins for the dads. Sleep was more disrupted for both parents after birth, but moms were more affected by incr WASO during last mo of pregnancy and 1st mo postpartum. Both parents reported more sleep disturb and fatigue during the 1st mo postpartum compared to pregnancy.	New Parents	Actigraph (AMI)	Start: NS End: NS Durat: 48 hrs x 2	Action3 Software (AMI	4 autoscored outcome variables: TST-night; TST-day; TST-24 hrs; and WASO	48-hr Sleep Logs x2 time points Subjective Measures- Clinical Assessments, Questionnaires, Scales	Consistent results between GSDS and acti measures of sleep with a loss of sleep for both parents post-partum and a greater loss of sleep at night in mothers post--partum.	For differences between groups and conditions, acti was consistent with self-reported perceptions of sleep disturbance in healthy new parents.
{Gnidovec, 2002 #638}	2	This study evaluated the validity of the Gachwiler actigraphy for assessment of sleep by comparing recordings with observations of 10 infants	Enroll:10 Compl:10	NA	60%	1, 3, and 6 months	See Actigraphy outcomes	NA	Gachwiler Actigraph, model Z80-32K (Gachwiler Electronics)	Start: End: Durat:72 hours each time	10 sec	Homegrown	Trained observer	1. Agreement between actigraphy and observation was 87% and 95% respectively at 3 and 6 months 2. Only 72% agreement between observers and actigraphy in 1 month old infants	High agreement between observer reports and acti estimates of sleep/wake in infants. Agreement was higher at 6 mos of age than at 1 mo.
{Gossel-Symank, 2004 #835}	4b	To investigate whether diffs in activity-rest behavior observed in pre-term vs full-term (control) neonates continue to persist at the age of 20 mos.	Enroll: 17 Compl: 17	8 FULL TERM	53% - Pre-terms 38%-Full-terms	~20 mos w/ age correction for the pre-term infants	All infants exhibited a clear circadian activity-rest rhythm w/ a dominant per betw 23hrs32min and 24hrs23mins, but the pre-term infants had an incr variability in ultradian per lengths. Daytime nap/rest duration was sign shorter in pre-terms (1hr38mins) compared to full-term infants (2hrs18mins).	Pre-term vs Full-term infants at ~20-mos	Actiwatch (Cambridge, Neurotechnology, Ltd)	Start: NS End: NS Durat: ~10 days	Actiwatch Sleep Analysis 2001, ver 1.03 (Cambridge, Neurotechnology, Ltd)	Fast Fourier Transform(FFT) w/ a time series of 5.68 days; Sleep/Wake Threshold=40 counts	Sleep Logs by parents	Pre-term infants had a shorter nocturnal sleep duration (9hrs55mins) compared to full-term infants (10hrs40mins). Moving time during sleep was elevated to 9.6% in pre-term infants compared to 7.5% in full-terms (p<.05)	Actigraphy used to assess differences in circadian rhythms and sleep duration between two pediatric groups.
{Grajewski, 2003 #1039}	3	An observational study of working flight attendants to determine whether they would be more likely than teachers (control group) to experience circadian disruption as measured by overnight melatonin production and to identify metrics of circadian disruption for large epidemiologic field studies in which biomonitoring would not be feasible.	Enroll: 45- flight attendants Compl: 63 (of the entire group of 71)	26 teachers	NA	36 +/- 4.7 yrs-Flight attendants 37.4 +/-5.9 yrs –Teachers	Flight attendants experienced incr circadian disruption as measured by a higher adjusted melatonin rate variance compared to teachers (p=.04). Time zones crossed corr w/ melatonin production and measures of sleep displacement.	Jet Lag in Flight attendants	Mini Motionlogger (AMI)	Start: NS End: NS Durat: 1 "menstrual cycle"	Action3 (AMI)	Cosinor analysis; Cole et al, 1992, Sleep, 15:461-9, modified for 3-min epochs; Corr analysis, exploratory principle components and factor analysis	24-hr Actigraphy Urinary Melatonin – 6-sulfatoxymelatonin (6SMT) Sleep Logs Subjective Measures – Flight hist records for 4 mos, Questionnaire covering 6 mos of travel hist for teachers	Comparison to reference standard Actigraphy and diary data were used to calculate the mean hourly rate of overnight 6SMT production. The number of time zones crossed was a useful indicator of both circadian sleep displacement and melatonin desynchronization. Transmeridian travel corr w/ variable shifts in the sleep- and worktimes of flight attendants w/ more sleep in the primary sleep period of the day. Incr Sleep Eff% corr w/ low melatonin.	
{Greco, 2004 #731}	5b	The objective of this study was to examine the association between psychoactive medications and sleep quality in a sample of nursing home patients. Baseline data from a larger clinical trial of a nonpharmacologic sleep intervention were examined.	Enroll:210 Compl:168 Prescribed 1 or more psychoactive medications=109 (Grp1)	Not prescribed psychoactive medication = 59 (Grp2)	Grp1=21 % Grp2=20 %	Grp1= 83.1 ± 8.6 Grp2= 85.4+8	65% of the patients were taking one or more psychoactive medications routinely. The number of minutes of sleep, percent of time in bed asleep and number of awakenings did not differ between those receiving and not receiving psychoactive medications. Significantly better sleep quality was not found in those using antidepressants, or those who were using psychoactive medications reported to cause sedation.	"Frail" nursing home patients, defined as "inability to transfer out of bed at night without human assistance."	Actillume (AMI)	Start:1900 End:0700 Durat: 3-5 nights (12h/nt) Sbjs with fewer than 3 nights data not included (so 20% of enrolled patients did not have 3 or more valid actigraphy nights	Though actigraphs were worn from 1900-0700, analyses based on 2100-0700.	Action3 - SUMACT	None	Actigraphy was the sole measure of sleep quality in this descriptive study. No relation between psychoactive medications and sleep quality was observed.	
{Guilleminault, 2002 #803}	3	Random stratification of insomniacs w/ UARS and insomniacs w/ normal breathing into 4 tx groups for 6-mos to determine whether UARS in postmenopausal insomnia is a primary factor in the complaint and whether tx of this mild SDB is enough to improve the insomnia over and above a Behavioral Tx Program.	Enroll: 130 (68 Insom w/ normal breathing; 62 Insom w/ UARS) Compl: 126	34 Insom w/ normal breathing were randomly assigned to the Delayed Behavioral tx cond as the Tx Control (got a booklet on Sleep Hygiene rxs)	0%	50-70 Years	Abnormal breathing during sleep significantly intensified complaints of daytime fatigue (but not insomnia), and this complaint improved w/ SDB tx compared to tx with a behavioral /cognitive regimen. However, the Behavioral tx program produced the best response in insomniacs w/out SDB and shortened sleep latency even in the SDB patients	Post-menopausal Insomniacs w/ Normal Breathing Post-menopausal Insomniacs w/ UARS	NS	Start: NS End: NS Durat: 7-days Baseline; 7-days at 6-mo f/u post tx	Commercially available software from Mini	Custom – based on prior clinical experience and simultaneous, Act and PSG monitoring	PSG Sleep Logs Subjective Measures ENT evaluation	There were no diffs in the duration of noct awakenings across the 4 tx groups at Base. All 4 tx groups (incl the Delayed Behav tx control) had higher TST's at the 6-mo f/u compared to Base. The CPAP treated subgroup had the least improve in TST. The nosesurg treated subgroup had the largest decr in short arousals across the night w/ a similar decr for the SDB-treated group as a whole. Improvements in acti measures associated w/decreased daytime fatigue.	Used as a follow-up measure for tx of SDB by assessing movements between 2 - 3 units (brief arousals)
{Guilleminault, 2002 #804}	4b	Survey to determine the incidence, type and severity of sleep disordered breathing (SDB) and upper airway anatomy in a cohort of post-menopausal women with *chronic* poor sleep for >6 mos.	Enroll: 503 Compl: 394	NA	0%	55-70 years	Out of 394 postmenopausal women with chronic Insomnia, 264 (67%) had an AHI =/> 5, with 164 picked up during home monitoring, and an extra 100 diagnosed by PSG. Another 62 (15.7%) were diagnosed with UARS. Women with an AHI=/> 5, were more likely to have a hx of childhood asthma, upper airway allergies, wisdom teeth extraction <30 yrs old, and a hx of brusism.	Post-menopausal women with chronic Insomnia	NS-?Actiwatch	Start: NS End: NS Durat: "7 days" (unclear if these were 24-hr recordings or just nights) Edentrace on 7th night	Commercially available software from Mini	Custom - based on prior clinical experience and simultaneous, Act and PSG monitoring.	PSG	**Comparison to reference standard** Ambulatory (Actigraphy) without EEG missed 100 out of 394 women (25.4%) w/ AHI =/> 5 and could not recognize UARS. Most of the missed cases had a low AHI w/ a predominance of hypops. All women had a Sleep Latency =/> 30 mins and an awakening of 20 mins on at least 1, out of 7, nights of Actigraphy.	
{Guilleminault, 2002 #814}	5	A description of 11 separate, case reports of atypical sexual behavior during sleep and the battery of procedures utilized to diagnose and treat them.	Enroll: 11 Compl: 9 had Actigraphy	NA	64%	18-38 yrs	All patients had a sleep disorder. No sexual assault was seen in the lab PSG. A combination of specific treatment for the parasomnia documented during testing and any co-morbid, psychiatric disorder led to control of the reported behavior in 10 of 11 patients, with tx control still present up to 5 yrs later.	Parasomnia: Atypical Sexual Behavior in Sleep	"Actigraphy" (Mini)	Start: NS End: NS Durat: 7-days (?repeated in some of the cases but NS)	Commercially Available software from Mini	Activity vs. Non-activity	PSG Sleep Logs Subjective Measures –structured interviews, questionnaires Clinical evals MSLT	Not adequately compared to any reference "Actigraphy is helpful only to document the frequency of nocturnal activity and its timing of occurrence on a 15-day or 3-week period," p335	

Author/Year/Citation #	Actigraph Evid Level	Study Description	# of patients	# contr	% of males	Mean Age ± SD, (range)	Study Outcomes	Condition (diagnosis)	Device	Recording Time (day / hours)	Analysis Method	Algorithms	Standard compared with	Actigraphy Outcomes	Actigraphy Conclusions
{Harper, 2001 #1278}	3	The goal of this study was to compare circadian activity and temperature rhythms in patients with AD, patients with frontotemporal dementia or Lewy body disease, and controls.	Enroll: Compl:38	8	100% in both groups	Int: 70.2 ± 1.0 Cntrl: 72.8 ± 2.1	Alzheimer patients showed increased nocturnal activity and a significant phase-delay in their rhythms of core-body temperature and activity compared with patients with FTD and controls. The activity rhythm of FTD patients was highly fragmented and phase-advanced in comparison with controls and apparently uncoupled from the rhythm of core-body temperature.	Probable Alzheimer's Disease per NINCDS-ADRDA criteria	AM-16 activity monitor (AMI, Ardsley, NY)	Start: noon End: Durat:72hrs	Interdaily stability, a periodogram-based algorithm measuring day-to-day stability of the rhythm, and intradaily variability, a measurement of the fragmentation of the activity rhythm that assesses the period-to-period variability of the rhythm, were used as nonparametric measures of the circadian rhythm of motor activity Cosinor analysis used to model circadian rhythm	Oddly, the software not specified	None	Interdaily stability was lower in both patient groups that in controls. In patients w/AD, both circadian activity and temperature rhythms were delayed relative to controls. However, in patients with FTD, the activity rhythm was fragmented and phase advanced.	In controls and patients w/AD, but not FTD, changes in the rhythm of activity paralleled changes in the temperature rhythm.
{Harrison, 2004 #1019}	3	To determine the relationship between light exposure, 24 hour sleep patterns and crying in healthy infants.	Enroll: Compl:56	NA	46.40%	Infants studied at 6, 9, and 12 weeks of age	Daytime sleep decreased with age and nighttime sleep increased with age	Healthy infants	Actiwatch (Cambridge Neurotechnology)	Start: 2400 Monday night End:2400 Thursday night Durat:72 hrs	NS	NS	Sleep Diary	Overall consistency between acti measures and parental reports of sleep. Reported sleep during the night increased with age, activity levels decreased during the night with increasing age. Activity levels at night and parental reports of good and poor sleepers were also consistent.	Activity measurements are consistent with parental diaries of sleep across the day and night in healthy infants.
{Harvey, 2005 #709}	3	To investigate sleep-related functioning and the sleep-wake cycle during a euthymic period in Bipolar I patients compared to patients with primary insomnia and normal sleepers.	Enroll: 40 (20 Bipolar; 20 Primary Insomnia) Compl: 34 (14 Bipolar; 20 Primary Insomnia)	20 Normal Sleepers	50%- Bipolar 45%- Insomnia 35%_ Normals	39.6 +/- 15.2 yrs- Bipolar 39.6 +/- 10.6 ys- Insomnia 35 +/- 13.4 yrs- Normals	70% of the euthymic, Bipolar patients had a clinically sign sleep disturbance; 55% met full dx criteria for primary insomnia (excluding the psych dx). The Bipolar group had higher levels of anxiety/fear around poor sleep and lower daytime activity compared to the other groups. Poorer sleep effic, a tendency to misperceive sleep, and dysfunctional beliefs about sleep, were comparable to the Insomnia group.	Insomnia Bipolar I	Actigraph (AMI)	Start: NS End: NS Durat: 8 days/nights	AMI software	Actigraph's Zero-Crossing Mode	Sleep Logs Subjective Measures	The sleep quality of the bipolar group was in between the insomnia and normal sleeper groups for all measures. Subjective sleep measures of SOL and WASO were greater and TST was lower than actigraphic estimates of sleep for both insom and bipolar groups.	In patients with sleep problems, subjective sleep quality was worse than acti estimates. Good sleepers tended to overestimate sleep quality relative to acti measures (not compared statistically).
{Hatfield, 2004 #751}	4b	This study sought to assess the impact of Alzheimers dementia on activity/rest cycles in home-dwelling pts at early stages of disease progression.	Enroll: 27 Compl:	19	Cntrl:53% Int:56%	Cntrl: 71.8 Int: 68.5	Increasing severity of dementia was associated with progressive disorganization and decreasing amplitude of the daily pattern of activity and rest within home-dwelling Alz disease subjects.	Alz dementia per DSM-IV and probably Alz disease per NINCDS-ADRDA criteria	Actiwatch (Cambridge Neurotechnology	Start:ns End:ns Durat:28dys	Non-parametric circadian rhythm analysis (NPCRA)	Clocklab software (Actmetrix, Evanston, IL)	None	NPCRA showed that the stability, consolidation, and peak/trough changes of activity in the mildly demented patients were indistinguishable from controls, and that the moderately demented pts showed marked perturbations with significantly lower stability, consolidation, and peak-trough differences.	Actigraphy demonstrated an ability to detect significant differences between groups (dementia severity) for consolidation of sleep/wake (NPCRA is a circadian analysis)
{Hedner, 2004 #636}	1	The study sought to examine a novel automated algorithm developed for actigraphic studies of normals compared to sleep apnea patients.	Enroll: Compl:228	NS	71%	Normals: 38.6+/- 15.5 All (normals + all SDB levels): 48.8+/-14	The actigraphy algorithm evaluated in this study provides a reasonably accurate estimation of sleep and wakefulness both in normals and patients with SDB when compared to PSG on an epoch-by-epoch basis.	SDB based on full PSG	Watch_Pat100 system (Itamar Medical, Caesarea, Israel) Actigraphy module embedded is from AMI	Start: ns End: ns Durat: 1 night	See pg 1562 for full details: very specific automated sleep/wake analysis program, which for this study was synchronized with PSG	Watch_Pat100 (ASWA software)	PSG	Across all subjects, sensitivity was 88.8%, specificity was 69.5%, and agreement was 84%. Sensitivity and agreement tended to go down with increasing SDB levels (from 91% to 85%, and 86% to 79%, respectively). Specificity was less affected by increasing SDB levels (ranged between 68% and 71%).	This specialized device and software had good agreement with PSG in normals, but less as SDB increased.
{Hilliker, 1992 #1354}	3	Counterbalanced, cross-over, double-blind study to examine the effect of triazolam/placebo on a simulated night shift schedule. Two tours of 5 nights in the lab (1 w/ triazolam and 1 w/placebo). Only the placebo tour data in response to morningness (MT) vs. eveningness (non-MT) tendency is reported in this paper.	Normal Ss, not patients Enroll: 15 Compl: 15 (7-MT's and 8-non-MT's)	NA	27%	Mean=41 yrs (32-53 yrs)	MT types were sleepier than non-MT types for most of the night shift. The degree of physiol sleepiness was severe with a mean MSLT Lat of <5mins from 0230 to 0630 hours for the MT group compared to >9mins until 0430 hours for the non-MT group. Neither group showed adaptation to either physiol or subj sleepiness across the 5 nights of study.	Simulated Night Shift in Normal Ss	Actigraph (AMI	Start: NS End: NS Durat: 4 days (unclear if these were 24-hr periods or just day sleep periods)	AMI softwar	Custom-prev publ in SLEEP(1991);14:14 0-6. Sleep=1st of 3 consec epochs of counts =/< 20; Wake>20 counts	PSG screening Sleep Logs Actigraphy Subjective Measures MSLT Repeated Test of Sustained Wakefulness	The mean, estimated sleep duration for the MT group (312.7 mins) was not sign different from that of the non-MT group (325.7 mins) by actigraphy. Concurrent sleep log estimates of sleep duration were much lower in the MT group (255.7 mins) compared to 342.5 mins for the non-MT group.	Compared to acti, the shorter duration sleepers tended to underestimat sleep duration while the longer duration sleepers tended to overestimat sleep duration.
{Hoekert, 2006 #1360}	2	Study is designed to determine if the Circadian Sleep Inventory for Normal and Pathological States (CSINAPS) is accurate for assessing the sleep/wake rhythm of elderly nursing home residents	Enroll:78 Compl:78	NA	6.40%	85 ± 6 (70-97)	Correlations between actigraphy and the CSINAPS (both items and subscales) are moderate at best, suggesting combining the use of both measures.	All but 3 of participants had a dx of dementia	Cambridge Neurotechnology, Actiwatch	Start:NS End:NS Durat:2 weeks	Sleepwatch Analysis System (Cambridge Neurotechnology)	NS	Circadian sleep inventory for normal and pathological states (CSINAPS)	Strong relationship between CSINAPS scores for bed time and get up time and actigraphy, but only moderate agreement for total sleep time. CSINAPS overestimated sleep time by 30 minutes relative to actigraphy.	Consistent with caregiver report of bedtime and wakelime. Actigraphy detects more wake than caregiver reports.
{Korszun, 2002 #807}	4b	To determine if nocturnal sleep and daytime activity levels were different in patients with fibromyalgia, fibromyalgia and co-morbid depression, or depression compared to healthy controls	Enrol:59 Compl:59	28	16.90%	Fibromyagia 49.2 ± 2.2 Fibromyalgia plus depression 48.2 ± 2.4 Depression 45.8 ± 2.7 Controls 53.4 ± 2.4	1. Fibromyalgia patients showed some increased movement at night and disturbed sleep but no decrease in sleep efficiency, or increase in daytime napping. 2. Fibromyalgia patients with depression had more disturbed sleep, and more daytime napping than controls and other fibromyalgia patients.	Fibromyalgia (n=16) Fibromyalgia with co-morbid depression (n=6) Recurrent depression (n=9)	Am Mini-motion logger	Start:NS End:NS Durat:5-7 days	Action-W software using Cole-Kripke Algorithms to define sleep		Healthy Control	Actigraphy was effective at demonstrating differences in movement at night, daytime activity, and daytime napping between the conditions in this pilot study.	Actigraphy could detect differences in sleep parameters between controls and subjects with fibromyalgia and co-morbid depression
{Korte, 2001 #1140}	4b	To determine w/ continuous activity monitoring whether pre-term neonates are adapting to the day-night cycle in the 1st week of life and approaching the acitivity-rest patterns of a full-term control group.	Enroll: 10 Compl: 10	10 full term	70% - pre-terms 40% - full-terms	34th –36th week of gestation – pre-terms 37th-42nd week of gestation – full-terms	Avg sleep time in pre-term infants was 9hrs1min at night and 8hrs54min during the day, w/ avg nightly sleep incr from 4th to 8th days of life (p<.05), exceeding day sleep time from day 6 onward. Total sleep time across 24-hrs was not diff betw groups. Pre-terms ate less (8.2 times/24-hrs) than full-terms (9.8 times/24hrs), w/ longer intervals betw feedings (2-hhrs) compared to full-terms (1-4hrs) but may have reflected diffs in environment conds.	Pre-term vs Full-term Neonates (1st week of life	Actiwatch (Cambridge Neurotechnology, Ltd)	Start: 3rd day of life for pre-terms;4th,5th or 7th day after birth for full-terms End: 8 days after start for all infants Durat: 8-days	Rhythmwatch and Sleepwatch software (Cambridge Neurotech, Ltd); Daytime=07:00-19:00;Nighttime= 19:00-07:00	Fast Fourier Transform(FFT) w/ a time series of 5.68 days; Wulff and Siegmund, 2000, Biol Rhythm Res, 31(5):581-602	Sleep Logs by parents	Circadian Amplitudes (in the freq spectra) were present in 7, of 10, of the full-terms in the 1st week of life compared to only 1 pre-term.	24-hr Actigraphy is a suitable non-invasive method to characterize inter-individual variability in the activity-rest behavior of pre-term and full-term neonates and diffs in sleep duration.
{Korte, 2004 #741}	3	24-hr actigraphy was used to determine the effects of 3 diff Modes of Delivery on the activity-rest cycle and sleep parameters (day sleep, night sleep, and sleep across 24-hrs) in the 1st week of life.	Enroll: 59 Compl: 57	NA	55%- Vaginal 58%- planned C-section 58% - Required C-section	(37th-42nd week of gestation) Medians= 39.5weeks-Vag; 39weeks-planned C-sect; 40weeks-Required C-sect	All neonates had several short rest phases and short activity phases during a 24-hr day. 83% of vaginally born neonates had a distinct circadian freq in their spectra compared to 55% of planned C-sects and 50% of the medically required C-sects. These diffs might reflect diff environmental conds, e.g. more immediate social interaction from the vaginal delivery moms vs the C-sect recovering moms. 24-hr actigraphy provides a useful tool for looking at the ontogeny of the activity-rest rhythms in neonates and infants.	Planned C-section; Medically Required C-section after start of Labor; or Vaginal Delivery	Actiwatch (Cambridge Neurotechnology, Ltd)	Start: 3-rd4th day of life End: 8th –9th day of life Durat: 6-days	Rhythmwatch and Actiwatch Sleep Analysis Software (Cambridge Neurotech, Ltd)	Fast Fourier Transform (FFT) w/ a time series of 5.68 days (Wulff and Siegmund, 2000, Biol Rhythm Res, 31(5):581-602)	24-hr Actigraphy Sleep Logs by parents	Blind, prospective comparison to reference standard In all 3 groups of neonates, the ave nighttime sleep was sign higher than the ave daytime sleep from the 3rd to 8th days of life (p<.001). Vaginally born and medically required C-sect neonates had sign more sleep bouts during the daytime from the 3rd to 8th days of life compared to the planned C-sect neonates (p<.05). There were no 24-hr diffs betw groups in sleep parameters.	
{Kripke, 2005 #681}	3	An attempt to replicate an earlier study by these authors of aberrant circadian phases in the aMT6s of seniors. An intentionally biased, sample of seniors w/ symptoms of either a sleep phase advance or delay were recruited for an ultra-short sleep-wake cycle protocol in the lab. A younger adult (control) group w/ no sleep disturbance was included.	Enroll: 62 Compl: 62 (20 seniors repeated the study 5-mos later for test-retest reliability)	25	Sex NS	69.3 +/-6.6 yrs (58-84 yrs)- Seniors 27 +/- 6.3 yrs (19-40 yrs)- Younger Adult Contrs	Failure to replicate previous findings. Not a single instance of aberrant circadian phase in salivary melatonin, urinary aMT6s excretion, oral temp, or cortisol excretion, was found in the seniors. Urinary aMT6s excretion was the most reliable circadian phase marker w/ high repeatability on retest (r=0.95;p<.001, N=18).	Seniors biased towards symptoms of ASPS/DSPS vs young-middle aged Adults w/ no sleep complaints	Actillume I (AMI)	Start: NS End: NS Durat: 10-11 days (1-week home baseline; 75-96 hrs in-lab)	NS	Custom- Sleep hand edited w/ sleep logs and validated algorithm (Jean-Louis et al, 2000, Physiol Behav, 68:347-352)	Actigraphy Sleep Logs Saliva and Urinary Melatonin Urinary free cortisol Oral Temps Subjective Measures	Actigraphic results were similar to sleep log data; age-related difference in sleep time; seniors slept 26.6% out of 24-hrs compared to 35.4% for younger adults p<.001). Acrophases of actigraphic sleep were earlier in seniors compared to younger adults (p<.001), despite no diff in 24-hr light input betw groups. Bedtime and wake time were significantly earlier than in young subjects. Cortisol was the only phase marker to show significant differences between groups. Repeatability of home sleep times (in those seniors studied twice) was high (r=0.87, p<.001 , N=16). The acrophase of Home sleep was significantly correlated with the acrophase of phase markers in the lab.	Phase of the sleep/wake rhythm at home was correlated with the timing of circadian phase markers.
{Lamond, 2005 #909}	3	To assess the impact of relay work on sleep quantity and whether train drivers are able to obtain quality sleep in relay vans during a short (<48-hrs) relay trip.	Enroll: 14 Compl: 14	NA	100%`	46.6 +/- 4.9 yrs	Although train drivers on relay trips are able to obtain sleep during short relay operations, the sleep duration is ~half of what is obtained at home and of poor subj quality. In addition, the timing of the sleep opportunities directly impacts the quantity, efficiency, and subj quality, of the sleep obtained.	Shift Work (Relay Train Drivers)	"Activity monitor" (Gaehwiler Electronic, Hombrechtikon, Switzerland)	Start: NS End: NS Durat: ~5 days (3 days Baseline at home then <48-hrs relay trip)	Actiware-sleep Software (Cambridge Neurotechnology Ltd) paired w/ sleep logs for LO and Wake-up Times	TST, SO Lat, Sleep Eff%, subj ratings of sleep quality and sleepiness before/after each sleep per	Sleep Logs Subjective Measures	Blind, prospective comparison to reference standard Train drivers obtained an ave of only 4-hrs sleep/opportunity during the relay trip compared to 7.8 hrs of sleep/night at home (p=.0001), and TST/24-hr per averaged 5.8 hrs (+/- 1.3hrs). Sleep in the relay van was assoc w/ longer SO Lats (p=.001), lower Sleep Eff% (p=.0001), and poorer subj quality (p=.0001) compared to home sleep. Eve (2000hrs) sleep opportunities in the relay van were assoc w/ the most sleep (4.6 hrs) compared to 3.6 hrs for either AM (0400hrs) or Day (1200hrs), although SO Lat was shortest and Slee.p Eff% highest during the Day opportunity	

Author/Year/Citation #	Actigraph Evid Level	Study Description	# of patients	# contr	% of males	Mean Age ± SD, (range)	Study Outcomes	Condition (diagnosis)	Device	Recording Time (day / hours)	Analysis Method	Algorithms	Standard compared with	Actigraphy Outcomes	Actigraphy Conclusions
{Larkin, 2005 #695}	4b	Goal of study was to quantify the associations of SDB, sleep duration, and c-reactive protein levels in adolescents	Enroll:143 Compl: all 143 completed study, but actigraphy data missing in 6 pts	NS	50%	13.8± 0.8	Adjusted mean CRP levels showed a dose-response relationship with SDB above a threshold of AHI>5, an association that was partially explained by overnight hypoxemia, and less so by average sleep duration.	PSG confirmed SDB dx in adolescents	Octogonal Sleep Watch 2.01; AMI	Start: ns End: ns Durat: 1wk (min 4 days)	Used "time above threshold data model"	Action-W	None	Sleep duration (assumed to be from actigraphy – see NOTES) significantly negatively correlated with c-reactive protein levels, BMI and AHI. Sleep duration significantly associated with CRP in models adjusted for age, sex, BMI percentile, and (BMI percentile)2	Measure of habitual sleep duration at home in adolescents.
{Leger, 2002 #1353}	3	To use PSG and actigraphy to evaluate the sleep patterns in Blind Ss living under normal social conditions, w/ free-running sleep/wake cycles and complaints of abnormal sleep/ daytime sleepiness. Sleep comparisons to sighted controls were included.	Enroll: 26 Compl: 24	24 - Normal Sighted; age and sex matched to blind P's	73%-Blind 79% - Sighted	44.3 +/- 12.1 yrs (26-67 yrs) – Blind Age matched Contrs (no contr for 2 Blind females –ages 61 and 67)	Blind S's were "free-running" despite normal and regular social interaction. They had lower TST with a Sleep Lat that was twice as long, and a reduced Sleep Eff% compared to age and sex paired sighted contrs. REM Lat was longer w/ a reduced REM% in the Blind S's. Cyclic sleep/wake probs w/ insomnia or EDS were found in 6 Blind S's. No corr was found betw the type of blindness or presence of prosthetic eyes and the different noct sleep and "free-running" pattern results.	Blind Subjects Sighted Contrs	Z80-32K V1 (Gaehwiler Electronic, France)	Start: Time-synched w/ the 1 PSG per S in lab End: NS Durat: 15-days	NS	NS	PSG Sleep Logs Subjective Measures	Free-running subjects with sleep episodes at night showed decrements in sleep quality relative to controls. Direct comparison of PSG and Actigraphy for 1 night showed no difference in TST. However Sleep Eff% was higher by Act than PSG. Over the 14 days of the study daytime naps and sleep episodes were frequent by acti in the Blind S's. PSQI showed poor sleep quality in the prior month.	Acti used to monitor 24-h sleep over 14 days in free running blind subjects. TST consistent w/PSG, but sleep efficiency was significantly higher by acti in these subjects with disturbed sleep.
{Lichstein, 2006 #1362}	1	A validation study of 1-night of Actigraphy to PSG "gold standard," and a sleep diary, in a random cohort of volunteers who met "conservative criteria for insomnia" and completed home sleep diaries (2-weeks).	Enroll: 68 Compl: 57	NA	46%	21-87 yrs Age stratified: 21-39=8 S's; 40-59=22 S's; 60-87=27 S's	Actigraphy estimates of WASO, TST, and Sleep Eff% were not sign diff from PSG. By contrast, Sleep Onset Lat and # of noct awakenings were sign diff betw Act and PSG. Neither Age, nor sex affected the diffs betw Act and PSG. To test for low power, a series of post-hoc power analyses were performed and confirmed that the study was large enough to detect medium-sized (d=0.5) diffs but not small diffs (d<0.4) among the 3 instruments: PSG, Act, and Diary, for the 5 sleep variables of interest.	Insomnia	AW64 Actiwatch (Mini)	Start: 9pm synced w/ PSG computer clock End: NS Durat: 1 Night	Actiware Sleep v. 3.3 (Mini)	High Sens=Activity count of 20 <20=Sleep w/ weighting of adjacent epochs; =/> 20=Wake	PSG Sleep Logs Subjective Measures	Actigraphy measured WASO, TST, Sleep Eff%, and # of noct awakenings w/ an acceptable degree of accuracy for clin eval of insomnia, but correlations were lower than from validation studies in normal controls. Actigraphy underestimated Sleep Lat compared to PSG. There was a mild to moderate bias for actigraphy to overestimate TST and sleep efficiency, but this was not uniform across the range of values. Actigraphy approxs to PSG were superior to Sleep Diary.	1. Acti reasonable in measuring WASO, TST, Sleep Eff% and # of noct awakenings, but not sleep latency, in insomniacs. 2. Not as close to PSG measures in insomniacs as in normals. 3. Actigraphy closer to PSG values than sleep diary to PSG.
{Lotjonen, 2003 #781}	1	To determine the reliability of Wrist Care in recording sleep-wake patterns of adults of various ages	Enroll:32 Compl:32	NA	25%	62 (26-89)	Both instruments were reliable for recording sleep and waking states.	Healthy controls	Actiwatch (actigraphy) and Wrist Care	Start: End: Durat:	Data from actigraphy and Wrist Care compared to PSG (1 night), Daytime activity compared using Actigraphy and Wrist Care	1) Method proposed by Jean-Louis et al and 2) Sadeh et al for scoring actigraphy and wrist care data	PSG Algorithms/Devices	1) Wrist Care and actigraphy had about 80% agreement w/ PSG regarding sleep/wake states 2) When compared w/diaries, had 87% agreement regarding naps 3) Both wrist care and actigraphy appeared to overestimate sleep time by 30-70 min	80% agreement w/ PSG but overestimates TST in healthy subjects (r = 0.70). Agreement was higher in middle aged than in elderly subjects.
{Martin, 2005 #703}	5a	Evaluation of SDB in nursing home residents using actigraphy and pulse oximetry	Enroll:109 Compl: 109 was total sample, but only 71 had "acceptable actigraphy recordings		26%	86.2+/-9.2	40% of nursing home residents with daytime sleepiness and night time sleep disruption had abnormal ODI. Of all observational variables assessed, only loud breathing during sleep was significantly correlated with ODI (r¼.284; p¼.003). When ODI was adjusted for estimated total sleep time, higher adjusted ODI was associated with higher body mass index (kg/m2).	Suspected SDB	Mini-motionlogger (AMI	Start: ns End:ns Durat: 1 night		ActionW	Subjective Measures	Acti used only to determine TST. TST = 4.3 ± 2.1; %sleep (TST/total monitoring time) = 47.9% ± 25.4; #wakenings=18.2 ± 8.4	
{Martin, 2006 #1361}	5b	This study is a secondary analysis of data collected during a trial of non-pharmacological measures to improve sleep. Questions addressed in this study included the relationship of daytime sleep to nocturnal sleep problems, a determination if clinical characteristics e.g., cognitive function would distinguish residents with sleep distruptions from those with such problems, and a determination if circadian rhythms were more disrupted in subjects with more daytime sleep and disrupted nocturnal sleep	Enroll:492 Compl:492	NA	19.60%	NS	1. 69% of the residents had daytime sleep episodes (were observed sleeping >15% of the time 2. Daytime sleepiness associated with decreased cognitive function more medical co-morbidity, greater impairment, and more time in bed 3. No significant differences between those with night sleep disturbances and those without nighttime sleep disturbances 4. Less robust circadian rhythms were associated with more daytime sleep	Of 184 whose charts were reviewed, 42% had a documented dx of dementia and 36% had a dx of depression	Am, Mini-motionlogger, and sometimes Actilume (if circadian rhythms studies)	Start: 2200 End:0600 (for night time recordings) Durat: 194 pts wore wrist actigraphy for 2 nights, 118 of the 194 pts (60.8%), wore a wrist actigraph for 72 hrs	Action 3 software	Weighted algorithms were then developed with various weights ranging from 0.1-0.5 High Sens=20 counts; Wake=/>20 counts/epoch; Sleep= <.20 counts w/ weighting of adjacent 2-mins	Subjective Measures	1.Resident slept on average only 60% of the time between 10 pm and 6 am, with 72% of those assessed (n=194) having nocturnal sleep disturbances 2. 97% percent of pts assessed (n=118) had abnormal circadian rhythms	
{Matsumoto, 1998 #1170}	2	This study compared PSG and actigraphy recordings using Action 3 sleep/wake scoring algorithm and different settings of the scoring factor in low and high efficiency sleepers. Epochs were scored as "true sleep" or "true wake".	Enroll:15 Compl:15	NA	13.30%	Shift workers 45.8 ± 9.0 Healthy volunteers 26.8 ±4.9	An algorithm with a weight of P=0.14 was most accurate in both high SE index and low SE index groups	Shiftworkers (n=10) Volunteers (n=5)	Actilume-AM	Start: End: Durat:2 nocturnal recording and 2 daytime recordings	Action 3 software (vers 3.15)	Weighted algorithms were then developed with various weights ranging from 0.1-0.5	PSG	There was significant variation in scoring accuracy in the high SE group. The setting of 0.14 was the best setting, with 92% agreement for true sleep and true wake. The setting has less of an effect in the low sleep efficiency group, and the setting of 0.14 resulted in 81% agreement.	The settings of the algorithm can have a significant impact on the scoring of sleep and wake by acti. Higher agreement w/PSG in good sleepers than in subjects w/lower SE%.
{McCrae, 2005 #689}	3	Community Seniors were stratified into 4 groups by subj reports of wake time during the night w/ or w/out complaints about sleep (Good or Poor Sleepers, Complaints, No Complaints) in a study to identify the sleep, health, psychological, and daytime functioning factors that would differentiate these 4 groups. Used both subjective and objective measures of sleep. Gender diffs were also considered.	Enroll: 116 Compl: 103 (Complete Actigraph data on 102)	NA	35%-GS/NC 50%-GS/C 37.5%-PS/NC 37%-PS/C	72.8 +/- 7.1 yrs (all 4 subgroups were comparable in Age)	Only health differentiated groups – complainers – across both categories of sleepers. Both poor and good sleepers who complained about their sleep reported 1-2 more chronic conds compared to NC. C/good sleepers reported more daytime fatigue than NC/poor sleepers.	Seniors (60 yrs and older)	Actiwatch-L (Mini)	Start: NS End: NS Durat: 14-days	Actiware-Sleep vol 3.3 (Mini) – SO/offset=1st and last 10-mins w/ no more than 1 epoch wake	Sleep Logs Subjective Measures	Actigraphic measures of sleep (e.g. latency, efficiency, total wake time) distinguished btween groups (NC/good sleepers and C/poor sleepers or NC/poor sleepers). NC/good sleeper and C/poor sleeper women slept more efficiently compared to their Male counterparts in these groups. Within-subject comparison between objective and subjective sleep measures showed high correlations for NC sleepers between actigraphy and sleep log estimates of TST (r ≥ 0.80), and latency for NC/poor sleepers, but there were no significant correlations between the two measures in subjects who complained of poor sleep.	High correlation between logs and acti for TST in non-complaining good sleepers, but not in subjects complaining of poor sleep.
{McCurry, 2004 #927}	5a	A presentation of 3 selected, case studies from an ongoing study of sleep problems in community-dwelling Alzheimer's disease (AD) patients. The goal is to develop and then empirically evaluate an in-home, behavioral/education tx program (6 sessions over 2 mos) for community AD patients and their caregivers.	NA	NA	33% (1 of 3)	77 and 83 yrs	Clinical and empirical evidence that in-home, behavioral/sleep hygiene rxs to caregivers can be helpful in treating sleep and nighttime behaviors in community-dwelling AD patients. Quantifiable improvement by sleep diaries, actigraphy, rating scales, and clinical interviews, was verified.	Alzheimer's disease with at least 1 sleep prob and nighttime behav 3 or more times/week	Actillume (AMI)	Start: NS End: NS Durat: 1-week x 3 time pts (Baseline, 2-mos (post tx) , and 6-mo f/u)	Action3 Software (AMI)	NS	Sleep Logs Subjective Measures Behavioral In	**Pilot study** in 3 subjects Actigraphy at 2-mos, post the behavioral/education tx program documented sleep improvements confirmed by subj ratings and sleep diaries. The 6-mo actigraphy continued to confirm improve in 1 patient, 1 had deteriorated and 1 had died.	
{McCurry, 2005 #902}	4b	To evaluate a sleep education program on improving sleep in dementia pts living at home with family caregivers	Enroll:14 Compl:11	17 15	Int:59% Cntrl: 53%	Int: 78, 8 Cntrl: 78, 7	Educational intervention showed greater reductions in nighttime awakenings, total awake time at night relative to controls at postintervention. At 6mo f/u, those differences remained, and int pts had fewer awakenings/hr and were awake for less time at each awakening.	Alzheimers (probably or possible) dx'ed by primary care MD	Actillume, AMI	Start:ns End:ns Durat:1wk	"maximum channel used to est daytime sleep b/c of increased sensitivity to movement decreased likelihood that pts sitting quietly awake during day would be recorded as sleep" ALL other actigraphy variables derived from sum activity channel.	Action 3	None	**Level 4** 1) Actigraphy outcomes were the primary study outcomes – see above. 2) Actigraphy also used to show that there were no sig differences b/w pt and caregiver on a) amount of daytime sleep, b) amount of daytime illumination & c) amt illum >1000lux (table 2)	Actigraphy is able to detect treatment-induced improvements in sleep in patients with dementia
{Middleton, 2002 #801}	3	To determine whether 2 lighting schedules – A: 12hrs at 200 lux/12hrs at <8 lux or B: 12hrs at 1000 lux/12hrs at <8 lux - can maintain circadian phase to a 24-hr day when neither sleep, nor activity are scheduled.	Normal S's Enroll: 12 (6–Schedule A; 6– Schedule B) Compl: 12	NA	100%	Schedule A S's: 21.5 +/- 4.2 yrs Schedule B S's: 24.3 +/- 1.6 yrs	On Light Schedule A (200 lux), 4, of 6, S's showed phase delays. On Schedule B (1000 lux), synchronization of the rest-activity cycle to 24 hrs was maintained but w/ a sign overall phase advance of 0.81 hrs in the rectal temp rhythm. Social interactions had no major effect on phase. Observations sugg that domestic intensity lighting requires scheduled sleep and activity to maintain circadian phase to a 24-hr day.	Healthy Normals	MiniMotionlogger (AMI)	Start: 8am End: NS Durat: 15 days – Schedule A 17-days – Schedule B	Action3 software (AMI) for all tagged "in bed" periods	Only cosinor data w/sign fits (p=<0.05) and % rhythms >40% for Act	24-hr Actigraphy 24-hr Rectal Temp Urinary Melatonin Sleep Logs Activity Logs	Subjects living under a 200/8 lux L/D cycle showed significant delays in rhythms of activity, sleep, CBT and aMT6s over the 14 days with a calculated period of 24.21 (activity). Subjects living under a 1000/8 lux L/D cycle showed slight but significant advances in CBT and aMT6s, with a calculated period of 23.93. The calculated period of activity rhythms at 23.97 was not significantly different from 24 h.	Shifts in sleep and activity rhythms are similar to those observed in circadian phase markers.
{Mongrain, 2004 #1351}	2	To compare the phase angle (temporal relationship) between the sleep schedule and circadian phase of rectal temp min and DLMO in M-type and E-type Ss. Ss were free to adopt a spontaneous sleep schedule.	Enroll: 24 12-M-types; 12-E- types Compl: 24	NA	50% in each Group	(19-34 yrs) 24.7 +/- 1.5 yrs= M-types 23.4 +/- 0.7 yrs= E-Types	Phase angles were very similar in the 2 groups. However, a later circadian phase was assoc w/ a shorter phase angle. For the same morn-even score, women had an earlier DLMO and a longer phase angle betw DLMO and wake-time. Overlap in the circadian phases occurred across groups and phase angles were longer in E-types compared to M-types in these Ss. Where there was non-overlap in phase, phase angles were shorter in E-type Ss. Morn-even preference reflects to 2 diff mechanisms.	Normals: Morning-Type vs. Evening-Type	Actiwatch-L (Mini)	Start: NS End: NS Durat: 8 days	NS	NS	PSG Sleep Logs 26-Hrs Rectal Temp Salivary Melatonin Subjective Measures	Earlier, estimated, mean bedtimes (~2.5hrs) and wake-times (~2.8hrs) occurred in M-types vs E-types. Both circad phase markers (DLMO and temp min) corr. w/ the timing of the sleep schedule (r ≥0.75).	Acti-measured sleep timing is strongly correlated with the timing of circadian phase markers.
{Monk, 2001 #1141}	3	This study evaluates the effect of a 90-minute afternoon nap on nocturnal sleep, circadian rhythms, and evening alertness and performance in healthy elderly persons. Studied both at home (Actigraphy) and in lab (PSG)	Enroll:9 Compl:9	NA	44.40%	78.6 years (74-87 years)	1. Nocturnal sleep was not adversely effected by longer afternoon nap (mean 58 minutes) in home environment, however in lab, statistically significant reduction in nocturnal sleep (48 minutes) 2. Also a small but statistically significant decrease in nocturnal sleep efficiency during nap condition in lab 3. Afternoon naps did not improve performance during evening or alter perceived alertness during evening	NA	NS	Start: End: Durat: 2 17-day periods (in home recordings)	NS	NS	PSG Sleep Logs Subjective Measures	Actigraphy and sleep logs showed a non-significant tendancy to decrease TST at night with daytime naps and a an increase in 24 h TST. Nocturnal TST was significantly lower by PSG. Sleep efficiency was slightly, but significantly, reduced as measured by PSG, but not by logs or actigraphy.	Consistent results between actigraphy and sleep logs for TST and sleep efficiency. PSG showed significant differences in TST, for actigraphy this was a non-significant trend.

Author/Year/Citation #	Actigraph Evid Level	Study Description	# of patients	# contr	% of males	Mean Age ± SD, (range)	Study Outcomes	Condition (diagnosis)	Device	Recording Time (day / hours)	Analysis Method	Algorithms	Standard compared with	Actigraphy Outcomes	Actigraphy Conclusions
{Monk, 2003 #778}	1	This paper describes four studies evaluating the reliability and validity of a new questionnaire (Sleep Timing Questionnaire). Study 2 compared the STQ and actigraphy.	Enroll:257 Compl:257 Study 2:23	Study 4, 40	42%	Study 1 46.3 ±20.5 (20-82) Study 2 45.1 ±17.3 (23-76) Study 3 33.5 ±13.2 (20-59) Study 4 55.4 ±18.4 (20-89)	The STQ is both reliable and valid for determining when an individual usually sleeps	Study 4 included 19 pts with depression, 15 pts with insomnia, 5 with other sleep disorders, 3 with other illnesses and 12 people who were caregivers of pts with Alzheimer's or organ transplants	Study 2 MM Actiwatch	Start: End: Durat: ≥ 1 wk	Study 2 in=house software	NS	Sleep Logs Subjective Measures	There was a significantly positive relationship between STQ and acti measures of activity offset (r = 0.59) and activity onset (r = 0.77). Most of the variance could be attributed to 2 subjects.	Good correlation between questionnaire bedtime and wakeitme and acti in the majority of healthy subjects.
{Montgomery-Downs, 2005 #680}	2	This prospective cross-sectional study tests the validity of actigraphy in making the diagnosis of PLMs in children	Enroll:118 Compl:99	NA	42%	7.8 ±2.2 (4-12)	Significant differences in number of movements according to diagnostic category	54% diagnosed with sleep disordered breathing, 38% primary snoring or normal PSG, and 15% with PLMD	Actiwatch-64 (MM)	Start: End: Durat:overnight	Actiwatch-PLMs software	Derived from ASDA criteria, w/ 2 sec assessment. Validated in adults but not children	PSG	1. Actigraphy over-estimated PLMs 2. Application of a correction factor improved accuracy, but different correction factors were required for each group and could not be applied accurately without knowing pt diagnosis	Actigraphy is not sufficiently accurate to diagnose PLMD in children
{Nelson, 2002 #793}	5b	To determine the effect of a verbal or image manipulation of a pre-sleep stressor (anticipated presentation the next day) on Sleep Onset Latency (diary and actigraphy) in patients w/ chronic insomnia.	Enroll: 59 Compl: 31 17-Verbal group 14-Image group	NA	45% overall 47%-Verbal 43%-Image	20.9 +/- 2.6 yrs --Verbal 19.8 +/- 1.9 yrs - Image	Ss/Ps who thought in images fell asleep faster and reported less anxiety and discomfort the following AM. Clinically, results argue for interventions that train SO insomniacs to incr thinking in images and reduce verbal rumination after lights out.	Primary Chronic Sleep Onset Insomnia (DSM-IV)	Actiwatch (AMI)	Start: Bedtime End: Risetime Durat: 1 Night	Action-W Software (AMI)	NS	Actigraphy Sleep Logs Subjective Measures	Report was confined to Sleep Lat. Although the Actigraphy estimate of Sleep Lat was longer in the Verbal group compared to the image group, this diff did not reach stat sign. Only the Subj estimates of Sleep Lat were stat sign.	
{Nelson, 2003 #784}	3	To compare the freq, emotional value, and content of spontaneous, pre-sleep mental imagery reported by chronic insomniacs vs good sleepers in the natural, home environment. And, to determine the effect of this pre-sleep imagery on Sleep Onset Latency as defined by diary and actigraphy.	Enroll: 28 Compl: 20	20	55% - whole group 45%-Insomniacs 65%-Good Sleepers	(18-36 yrs – whole group) 21.4 +/- 2.2 yrs-Insomniacs 23.3 +/- 5.1 yrs-Good Sleepers	Controlling for the longer Sleep Lat, the Insomnia group had a higher % of unpleasant images compared to good sleepers (p<.01). A positive corr betw unpleasant images and subjective Sleep Onset Lat (p<.05)was found for the Insomnia group, but not the good sleepers. The insomnia group experienced more images around intimate relationships and sleep (p<.05) and fewer random/un-connected topics (p<.01) compared to the good sleepers.	Primary Sleep Onset Insomnia vs Good Sleepers (DSM-IV dxes/co-morbidity were permitted in both groups)	Mini-Motionlogger Actiwatch (AMI)	Start: NS End: NS Durat: 1-night	Action-W (AMI)	Zero-Crossing Mode	Actigraphy Sleep Logs Subjective Measures	Report was confined to Sleep Lat. Insomniacs had a sign longer subjective and objective SOL compared to the good sleepers (p<.001), so it became a covariate control factor for all imagery analyses.	Significant differences in both subjective and objective SOL in insomniacs vs. good sleepers.
{Nishihara, 2002 #669}	4b	This study evaluated the development of circadian rhythms in newborn Japanese infants by comparing sleep wake patterns of mothers and their babies at 3, 6, 9 and 12 weeks of age	Enroll:11 pairs Compl:11 pairs	NA	36% of infants	Infants studied at 3, 6, 9 and 12 weeks after birth. Mothers 28.8 ± 2.6 years	1. Circadian rhythms of activity began developing as early as 3 weeks of age, clear 24 hour peak in activity had developed by 12 weeks of age	NA	Actiwatch (MM)	Start: End: Durat:3-5 days on 3 occasions	NS	NS	Sleep Logs	Detected the development of circadian sleep/wake rhythms from 3 to 12 weeks of age in infants and the association of infants sleep/wake rhythms with those of the mother.	Acti useful to assess circadian rhythms of sleep/wake activity in infants.
{Noseda, 2002 #798}	5a	This study aimed to compare the effects of CPAP alone, CPAP+clonazepam, and clonazepam alone in patients with mild-moderate SAHS and high leg activity.	Enroll:14 Compl	NA	13/14=93%	54±12	Design: Each of the 14 pts were recorded on 3 consecutive nights with CPAP, CPAP+clon, and clon, respectively.	SDB (AHI b/w 10 &50) and leg movmenet index based on time in bed of >15	NS	Start: NS End:NS Durat: 3 consec nights			None	Each of the 3 txs effective in reducing LMI based on TIB	Acti-used to measure treatment-induced changes in leg activity
{O'Reardon, 2004 #915}	1	Wrist actigraphy and daily diaries were used to compare the daily pattern and timing of food intake relative to sleep-wake profiles (sleep timing and continuity) in obese patients diagnosed with nocturnal eating syndrome (NES) relative to a matched group of healthy, but obese, control Ss.	Enroll: 46 Compl: 46	43	30% -NES Ps 35% - Controls	43.3 +/- 9.8 yrs – NES Ps 39 +/- 11 yrs – Controls	There was no dif betw the total caloric intake of the NES vs control Ss, but the temporal pattern of caloric intake of the NES Ps was delayed relative to Controls. Food intake after the eve meal was incr by >3-fold in NES Ps compared to controls (p=.001). NES Ps consumed food during 74% of noct awakenings vs. 0% for the controls.	Obese Ps w/ Noctural Eating Syndrome vs Obese Controls	Actiwatch-L Mini-Logger Series (Mini)	Start: NS End: NS Durat: 10days/11 nights	Mini – but NS	Custom-Manually (blind to condition) matched to accompanying sleep logs for timing of sleep onset and offset, sleep period durat, and # of awakenings accompanied by getting out of bed	Sleep Logs Mood Log Subjective Measures	Blind, prospective comparison to reference standard Good convergence of sleep diaries with actigraphy for both groups (r's =/> 0.85). Sleep onset, offset, and total sleep durat times were comparable between Ps and controls. NES Ps reported more noct awakenings compared to controls (p<.001) and their actigraphically estimated arousals occurred earlier during sleep (128 mins after SO) compared to controls (193 mins after SO, p=.01).	
{Paavilainen, 2005 #702}	4a	The main goal of the study was to determine how activity (as measured by a telemetric actigraphy) differs between demented and non-demented nursing home residents, and to see actigraphy correlates with subjective sleep quality.	Enroll: Compl:23	19	NS	Exp: 84, 9.5 Cntrl81.5, 9	The demented pts had lower daytime activity and higher nocturnal activity than the non-demented pts.	Nursing home residency	Vivago (IST Oy, Helsinki, Finland)	Start: ns End: ns Durat: N#1>10 days; N#2 = 113 days [NOTE: For data analysis, only the first 10 complete days of data were used]	Analyzed in 3 periods that divided up a 24-hour period. Used a Poincare (return) plot analysis	NS	Subjective Measures	Significant differences in activity between demented and non-demented. Correlations between daily sleep-assessments and activity parameters were low, but statistically significant; for example, correlation coefficients between the night/day activity (mean) ratio and 1) quality of sleep and 2) daytime alertness were 0.27 and 0.24, respectively (both p<.001).	Activity level is weakly associated with subjective sleep quality.There was no sleep analysis conducted.
{Paavonen, 2002 #674}	2	This study compared the results of two different placements (waist and non-dominant wrist) of actigraphy recorders in primary aged schoolchildren	Enroll:20 Compl:20	NA	30%	10.5 years (7.3-13.3)	See Actigraphy outcomes	NA	Mini-motionlogers (AMI)	Start: End: Durat:72 hours	ACT2000 and AW2 software	Sadeh et al algorithm	Devices	1. Overall minute by minute scoring comparisons was 92.5% (range 82.3%-97.7%) 2. Correlation coefficients for sleep variables were all significant e.g., r=0.78-0.91	There were no significant differences in nocturnal sleep estimates between the two placements in elementary school age children. Diurnal activity measurements may be more affected by placement.
{Paavonen, 2003 #657}	4b	An open, clinical trial to determine whether melatonin is effective in treating sleep problems in children w/ Asperger disorder. To also assess whether amelioration of sleep disturbances improves behavior and well-being.	Enroll: 15 Compl: 15	NA	87%	6-17 yrs old	Sleep improvement during melatonin tx was assoc w/ improvement in behavioral and emotional parameters reported by parents and teachers. This tx effect was observed w/in a few days of initiation and disappeared soon after discontinuation.	Children w/ Asperger disorder (by DSM-IV)	Mini-MotionLogger (AMI)	Start: NS End: NS Durat: 48-72hrs x3 time pts	ACT2000 and AW2 Software (AMI)	TST, Sleep Eff%, SO Lat, #of awakenings (Sadeh at al, 1989, J Ambulatory Monitoring, 2:209-216).	24-hr Actigraphy Sleep Logs concurrent w/ actigraphy Subjective Measures	Acti revealed baseline to post-tx changes in sleep parameters in children with Asperger's Syndrome.	
{Penzel, 2004 #725}	2	Investigation of a new ambulatory recording system that uses peripheral arterial tonometry (PAT), oximetry and actigraphy (Watch-PAT) to detect sleep apnea and arousals	Enroll:21 Compl:17	NA	NS	Only range reported: 30-69	Correlation b/w RDI derived from PSG and Watch-PAT system was 0.89 (no p-value reported, but authors state it is "significant"	Either 1) suspicion for SDB and referral for sleep study or 2) Pts diagnosed with SDB and on CPAP for at least 3 mos	Watch-PAT (Itamar Medical, Caesarea, Israel)	Start: NS End: NS Durat: 1 night		Proprietary to Watch-PAT.	PSG	No significant correlation between TST derived by PSG and by actigraphy. Bland-Altman shows much scatter, which the authors state " corresponds to a very limited confidence in the TST in these patients, as predicted by the Watch-PAT device." Mean of the differences in TST was 12.17 +/- 64.5 min	Specialized device for assessment of sleep apnea and arousal. Automatic evaluation of "wake" vs. "sleep" based on activity level; also evaluates oxygen saturations and the PAT signal attenuations.No correlation for TST w/PSG
{Pillar, 2003 #761}	4b	This study sought to examine and validate the accuracy of the Watch_PAT 100 in the detection of arousals from sleep, as defined by AASM.	Enroll: 68 Compl:	[Note: 61 pts referred for SDB evaluation and 7 healthy volunteers	79%	46 +/- 14	Significant correlation coefficients between arousals scored from PSG and those derived from WP100 device (r=.87). [see more detail on outcomes below, under "Actigraphy Outcomes."]	SDB	Watch_PAT 100 (3 signals: actigraphy, PAT, oximetry)	Start: ns End: ns Durat: 1 night sleep in lab	"sleep/wake determined by actigraphy;" arousals scored automatically using an improvement of an algorithm previously described (see Pillar et al, 2003; Sleep)	Algorithm scores arousal if one of following conditions is fulfilled within an epoch of sleep: 1) association b/w 2 events (see text for more detail); 2) an association b/w PAT signal amplitude attenuation of more than 40% and short movements of the patient, detected by energy of the actigraphic signal.	PSG	Demonstrated ability to detect significant difference between groups or conditions in well-designed trial Sensitivity and specificity of PAT in detecting pts with at least 20 arousals/hr of sleep were .80 and .79, resp. Area under the ROC was .87	
{Provini, 2005 #675}	3	Continuous actigraphy and sleep logs were used across a double-blind, crossover randomized study of the D3-receptor agonist, non-ergoline derivative, pramipexole, for the tx of SRED in 11 Ps presenting to a sleep clinic. A 2-week washout per occurred between drug and placebo conditions.	Enroll: 11 Compl: 11	NA	30%	49 +/- 16 yrs	Pramipexole was well tolerated w/out any patient w/drawing from the study. 9 of 11 Ps incr to max drug (0.36mg) or placebo (2 tabs) dose allowed. The median night-time activity decreased (p=.02) while the # of good sleep nights/week increased (p=.02) on pramipexole. No sign changes in body wt or in absolute disease severity occurred on drug or placebo.	Sleep-related Eating Disorder	Mini Motionlogger Actigraph Advanced (AMI)	Start: NS End: NS Durat: 4-6 weeks (not cont, 1week baseline, 2nd-3rd weeks on drug or placebo)	NS	NS	PSG Actigraphy Sleep Logs Subjective Measures Periodic blood, urine, ECG monitoring	Only the median noct activity was sign reduced on drug. The only subjective measure to be better on tx than placebo was the nights of good sleep/week.	Minimal effect of tx on either subjective or objective measures. Study may have been underpowered to detect diffs.

Author/Year/Citation #	Actigraph Evid Level	Study Description	# of patients	# contr	% of males	Mean Age ± SD, (range)	Study Outcomes	Condition (diagnosis)	Device	Recording Time (day / hours)	Analysis Method	Algorithms	Standard compared with	Actigraphy Outcomes	Actigraphy Conclusions
{Regestein, 2004 #749}	1	To determine if self-reported sleep measured by the St. Mary's Hospital Sleep Questionnaire was related to objective sleep, cognitive performance, and motor performance	Enroll:88 Compl:88		0	45-66	1. Poor sleep quality was associated with increased risk of psychological and somatic symptoms, poorer cognitive function 2.Self reported low sleep quality showed little correlation with objective measures	Healthy women with hot flashes	MM, no specific type of actiwatch named	Start:NS End:NS Durat:7 days	Appears to be developed in house, references Webster, Kripke et al, 1982 and Cole et al, 1992 for description of method	NS	Sleep logs	There was a significant but small avg. difference between objective and subjective sleep quality (avg diff of 7.5 min). The variation was large, with a correlation of r = 0.31. Women who had self-reported sleep latencies longer than normal, over-estimated their sleep onset time by 30 minutes, Women who had shorter than average self-reported sleep latencies under-estimate their sleep latencies by 15 minutes.	The longer the subjective sleep latency the more it differed from acti. The shorter self-reported TST, the more it differed from acti.
{Richards, 2001 #1133}	4b	This was pilot study designed to test the effect of an individualized program of individualized activities designed to enhance sleep in cognitively impaired patients residing in a dementia care unit. Patients wore actigraphy for 3 consecutive days during baseline and 3 days during intervention to measure sleep wake patterns.	Enroll:7 Compl:5	NS	100%	76.2 ± 8.0 (70-89)	Results showed an increase in nocturnal sleep (327 ± 155 min to 354 ± 146 min) with increased efficiency and a decrease in daytime napping (106 ± 68 min to 80 ± 51 min) from baseline to post-intervention.	Dementia – either probably AD or vascular dementia	NS	Start: End: Durat: 3 days	NS	Software also not mentioned	None	Demonstrated ability to detect significant difference between groups or conditions in well-designed trial See study outcomes.	
{Richards, 2005 #639}	4b	The goal of this study was to test the efficacy of an individualized social activity intervention (ISAI) on improving sleep disturbances through a randomized trial using a pretest/posttest design in nursing home patients with dementia.	Total Study Enroll:172 Compl:139	Int:71 68	52%	79 ± 8.4 (range NS)	The individualized social activity intervention recuced daytime sleep (71.6 ± 69 vs. 110.8 ± 68.7 min) and lowered the day/night sleep ratio (0.48 ± 0.58 vs. 0.64 ± 0.80) cpm[ared to the control group.	Dementia (MMSE<24) and sleep efficiency <85% as measured by actigraphy	Actigraph (AMI)	Start: End: Durat: Days1-5 of baseline and 17-21 of treatment/control	Variables automatically derived from Actigraph software.	Actigraph software	None	Acti measured less daytime sleep (71.6 ± 69 vs. 110.8 ± 68.7 min) and lower day/night sleep ratio (0.48 ± 0.58 vs. 0.64 ± 0.80) in the intervention than the control group. Actigraphically-measured nighttime sleep variables were not different between the groups (minutes to sleep onset, minutes slept, minutes awake and sleep efficiency) .	Acti measured treatment outcome in nursing home patients with dementia
{Ruths, 2004 #724}	2	A randomized, reference group controlled, double-blind study of abrupt discontinuation of antipsychotic meds (for non-psychotic indications) in nursing home residents w/ dementia. Continuous actigraphy and periodic Behav/symptom ratings (NPI-Q) were carried out across a 6-week study period where the Intervention group remained off of antipsychotics for 4 weeks and the reference group continued on meds.	Enroll: 30 Compl: 28	14 Ps in Ref group	20%	83.4 +/- 6.9 yrs	Following antipsychotic w/drawal, behavioral scores remained stable or improved in 11 Ps and worsened in 4 Ps. One patient was restarted on antipsychotics, 9 days after w/drawal due to incr leg movements.	Nursing Home Dementia Residents	Actiwatch (Cambridge Neurotechnology, Ltd)	Start NS End: NS Durat: >6 weeks	Proprietary Software – 3, 7-day record files: 2nd Baseline week, Weeks 1 and 4 of the intervention to corres w/ the timing of the NPI-Q ratings.	Pre-defined nighttime window of 11pm to 7am	Actigraphy Sleep Logs Subjective Measures Inventory Questionnaire	Actigraphy estimates showed a decr sleep effic% from 86% to 75% (54 mins, p=.029)w/ abrupt drug w/drawal. Restlessness was sign correlated w/ mean estimates of 24-hour activity (r=0.64,p<.001) and daytime activity (r=0.62,p<.001) in both groups, while sleep probs (NPI-Q) were corr w/ nighttime activity (r=0.60,p=.001).	Significant associations between ratings of restlessnes and activity level, and between ratings of sleep problems and night time activity. The association between rating of sleep problems and sleep efficiency did not reach significance.
{Rybarczyk, 2002 #808}	2	This study was designed to test two behavioral treatments for individuals with geriatric insomnia versus a control condition. (CBT, home-based audio relaxation treatment [HART])	CBT, HART, Control (in that order) Enroll: 16, 18, 17 Completed treatment: 11, 14, 13 Compl F/u: 10, 13, 12		64%, 29%, 38%	66.5, 65.6, 71.4	CBT and HART groups showed significant improvement on 5 and 3, respectively, out of 7 self-report measures of sleep at 4 mo f/u. No significant changes in sleep measures were seen for sleep variables measured via actigraphy.	Insomnia	Model BMA (AMI	Start: ns End: ns Durat: 1 week duration at 3 different time points	Action W (variables: TST, SE, WASO)	Cole-Kripke	Sleep Logs	Correlations b/w actigraphic and self-reported sleep measures were generally very low, with average correlations across pre- and post-tx and f/u being: -0.14 for SE; 0.08 for WASO; & 0.03 for TST. Also, repeated measures ANOVA revealed no group X time effect for SE, WASO or TST.	Very low correlations were found between acti and self-reported sleep measures in older adults with insomnia and co-morbid illness
{Sadeh, 2004 #726}	3	To assess the role of coping style in moderating the link betw stress and sleep in normal sleepers, 2 stress conditions were chosen. Nightly actigraphy occurred across a normal 5-day academic period (low stress condition) and again across a 5-day period during the eval week for acceptance into grad school (high stress).	Normal Ss Enroll: 36 Compl: 36	NA	22%	24.75 +/- 2.17 yrs (22-32 yrs)	Ss w/ high emotion focused coping (EFC) shortened their sleep, while those w/ low EFC extended their sleep during the high stress period (p<.005). Problem focused coping (PFC) was assoc w/ more sleep (longer sleep period, p<.05 and total sleep time, p<.005) irrespective of high or low stress cond.	Normal Sleepers	AMA-32 Actigraph (AMI)	Start: Bedtime End: AM Rise time Durat: 5 consec nights x 2-time pts (low-stress week and high-stress week	AMI software – Mode 18 data collection	Custom Software: Actigraphic Scoring Analysis program for an IBM compat PC (Sadeh et al, 1994); 90% validation w/PSG	Actigraphy Sleep Logs Subjective Measures	Decreases in sleep time from low-stress to high-stress conditions were observed w/acti. Perceived sleep quality also decreased in high stress conditions (high EFC group)	Acti used as an outcome measure to detect stress-related changes in sleep.
{Sadeh, 2004 #735}	2	Study I, of 2 studies, was employed to develop and validate (w/ both subjective-sleep diary and objective-actigraphy methods) a brief, infant sleep questionnaire (BISQ) that would be appropriate for screening in pediatric settings. (Study II was an internet application of the BISQ.)	Enroll: 43Compl: 43	57 (actigraphy data from 55available)	60%-clinical group53%-controls	12.3 mos +/- 5.5mos (6-29 mos)-clinical group14.4 mos +/- 6.3 mos(5-26 mos)-controls	Psychometric, clinical, and ecological support was generated for the use of the BISQ as an infant sleep screening tool for clinical and research purposes. Test-retest reliability w/ repeated administrations of the BISQ were highly sign (P<.0001) for Noct TST (r=.82), daytime sleep duration (r=.89), # of night awakenings (r=.88), noct wakefulness duration (r=.95), noct SO Lat (r=.95), and settling time (r=.94). Clinical Guidelines for referrals: >3 awakes/night, >hour of wakefulness during night, or <9hrs of sleep/24-hr period for ages 6-30 mos.	Infants/toddlers	AMA-32 Actigraph (AMI)	Start: NSEnd: NSDurat: 5-7 days	NS	SO Lat, SPT, TST, # of night awakes =/>5mins	24-hr Actigraphy Sleep Logs Subjective Measures	Only applies to Study I. Sign, but low, corrs were found betw the BISQ and actigraphic SO Lat (r=0.54; p<.001) and # of night awakes (r=0.42;p<.0001). The strongest corrs were betw daily log and actigraphic SO Lat (r=0.96; P<.0001)) and noct TST (r=0.87,p<.0001).	High correlations between daily caregiver sleep logs and acti in infants for SOL and TST. Retrospective data and acti had low to moderate correlations.
{Sazonov, 2004 #719}	5a	This study used actigraphy to determine the sleeping position of infants and measure their sleep/wake patterns	Enroll: Compl:26	NS	NS	34-42 weeks post-conceptual age	Accelerometer can be used to determine infant position	Participants included normal term infants, preterm infants, term infants with SIDS sibling, preterm infants with SIDS sibling	Accelerometer (brand not stated)	Start: End: Durat: mean PSG recording 7 hrs 54 min	Homegrown, involving logistic regressions and neural networks	NS	PSG	Both regression models and neural models had a tendency to over predict sleep	
{Scherder, 2003 #772}	5b	A randomly assigned, single-blind, clinical trial of low-freq (CES) or placebo (no current applied) was carried out to assess the effects on the circadian activity-rest cycle and cortisol levels of institutionalized patients w/ Alzheimer's disease (AD).	Enroll: 8 Compl: 8	8	25%-Experimental 12%-Control	(Only group means; no SD's given)86.75 yrs – Experin87.88 yrs - Contrs	Low-freq CES had no sign effects on the rest-activity rhythm and/or cortisol levels in AD patients. Salivary cortisol incr after both CES and placebo.	Early Alzheimer's Disease (by NINCDS-ADRDA criteria)	Actiwatch (Cambridge, Neurotechnology)	Start: NS End: NS Durat: 1-week x3 time pts	Actiwatch Sleep Analysis 2001 Software (Cambridge, Neurotechnology)	Interdaily Stability(IS)-strength of coupling; Intradaily Variability(IV); Relative Amplitude(RA)	24-hr Actigraphy Sleep/Wake Logs Subjective Measure	No effect of cranial electro-stimulation on the rest-activity cycle.	
{Semler, 2005 #691}	3	A randomly assigned, counterbalanced study designed to manipulate positive vs negative, subjective perceptions about sleep in insomniacs through positive vs negative text feedback on the prior night's sleep.	Enroll: 33 Compl: 22	NA	25%	21.4 +/- 3.7 yrs	Negative feedback was assoc w/ more negative thoughts (p<.001), sleepiness (p<.01), monitoring for sleep-related threat (p<.01), and safety behaviors during the day (p<.001) relative to positive feedback.	Primary Insomnia (by DSM-IV)	Mini-MotionLogger Actigraph (AMI)	Start: NS End: NSDurat: 3 consec nights	Action-W Software (AMI)	Zero-Crossing Mode	Actigraphy Sleep/Wake Logs Subjective Measures	Under Negative feedback, incr monitoring for sleep-related threat (p=.003) and more safety behaviors during the day (p=.009) were assoc w/ actigraphic estimates of TST>6.5hrs compared to the group that received positive feedback but slept<6.5hrs. Actigraphic estimates of sleep did not differ sign by either feedback or night.	Used in an experimental protocol to assess the impact of subjective estimates of sleep when objectively measured sleep is the same.
{Serfaty, 2002 #792}	3	The goal of this study was to examine the effect of exogenous melatonin (6mg) on sleep disturbance associated with dementia via a randomised double blind placebo controlled cross over trial.	Enroll:44 Compl:25	NS	16/25= 64%	84.2 +7.6	Sleep was significantly disturbed in the sample population. Melatonin had no effect on median total time asleep (n=25, z=1.35, p=0.18), number of awakenings (n=25, z=0.32, p=0.75) or sleep efficiency (n=25, z=0.17, p=0.24). Nor were there any carry over effects from melatonin.	DSM-IV diagnoses of dementia; sleep disturbance as identified by main caregiver - defined as shouting or agitated behaviour and/or wandering on at least two nights per week	"Wrist actigraphy monitors & analysis software" supplied by Neurim Pharmaceuticals Ltd (Tel Aviv, Israel)	Start: End: Durat: night period, only (not day)	NS	NS	Sleep Logs Subjective Measures	There was no effect of the intervention on sleep parameters measured by acti or by reports of sleep quality by visual analog scales. Caregiver reports were rarely filled out and there was no correlation between reports from diary sheets and objective information from sleep obtained from wrist actigraphy.	Acti used as an outcome measure in RCT in patients with dementia and sleep problems. Acti data lost from many subjects due to removal or refusal to wear watches, but less lost data than from caregiver reports. Sleep diary reports could not be used.
{Shibui, 1998 #1350}	4b	Report of a single case – man with non-24h sleep-wake syndrome.	Enroll: Compl:1		1%	43	Free-running sleep wake cycle was 25.8 h long; once this patients sleep-wake cycle and temperature rhythm became synchronous with this duration, his fatigue symptoms completely disappeared. Artificial bright light treatment allowed entrainment to 24h day without recurrence of fatigue symptoms.	Non-24h sleep-wake syndrome per ICSD (1990)	Actigraph, AMI	NS	Very little description of how data analyzed, other than plotting of actigraphy data.		None	Demonstrated ability to detect significant difference between groups or conditions in well-designed trial See study outcomes.	
{Singer, 2003 #651}	2	This study was designed to examine the safety and efficacy of melatonin's soporific effect in patients with Alzheimer's Disease and nocturnal insomnia. Patients were randomized to either placebo, 2.5mg, or 10mg melatonin.	Enroll//Comp 2.5mg=54/1 10mg=51/4	Enroll/Comp Placebo=52/5	44%	77+/-9	Melatonin did not have a significant effect on objective sleep measures.	Insomnia in AD pts	Actiwatch AW64 (Mini-Mitter)	Start:NS End:NS Durat: Actigraphs were worn continuously throughout the 2- to 3-week screening period and the 10-week protocol.	Data gaps in a 24-hr period resulted in that segment being deleted. Single actigraphic record put together for entire 8 week treatment period. Noon to noon segments were created by the analysis program.	Actiwatch AW64 series sleep-algorithm	PSG Subjective Measures	In a subanalysis of the main study, sleep measured by actigraphy and PSG correlated r= .92, p<.01 in a subset of the sample (n=7 pts over a total of 18 nights). The mean difference in TST was 55.5 minutes (Act mean TST=389.9min; PSG mean TST=334.4min).	High correlation between acti and PSG, but acti consistently overestimated sleep in Alzheimer's patients.
{Skjerve, 2004 #728}	4b	To evaluate the effect of bright light treatment on behavioral symptoms and activity level in patients with severe dementia	Enroll:11Compl: 10	NS	70%	79 (range 65-87)	No improvement was found in sleep-wake measures after bright light treatment in the small sample of severe dementia patients. Measures included mesor, sleep efficiency, interdaily stability, intradaily variability, & relative amplitude. However, an effect was found for acrophase, such that activity acrophase late in the day during T1 (pre-tx) predicted a higher level of advance during T2 (during tx).	Severe dementia per Clinical Dementia Rating score	Actiwatch (Cambridge Neuro)	Start:ns End:ns Durat: 24h/d for 6wks of study (1 wk before tx; 4 wks during tx; 1 wk post-tx	NS	Ns, though actiwatch software assumed	None	No changes in sleep measures were observed. Bright light advanced the acrophase of the acti rhythm.	Ability to detect rhythm of activity in patients with severe dementia.

Author/Year/Citation #	Actigraph Evid Level	Study Description	# of patients	# contr	% of males	Mean Age ± SD, (range)	Study Outcomes	Condition (diagnosis)	Device	Recording Time (day / hours)	Analysis Method	Algorithms	Standard compared with	Actigraphy Outcomes	Actigraphy Conclusions
{Tang, 2004 #650}	3	A behavioral experiment designed to correct the perceptual distortion about sleep in patients w/ primary insomnia by supplying direct participatory feedback.	Enroll: 52 Compl: 40	NA	30%	(18-46 yrs)22.8 +/- 5.2 yrs-Shown Discrepancy24.6 +/- 7 yrs – Not Shown	Subj SO Lat estimates for the 3-nights after the intervent (shown discrepancy from Base data) were shorter relative to the Base 3-nights (p<.002). Subj estimates of TST were longer (over the next 3-nights) post- the intervention compared to pre-(Base) 3-nights (p<.001). Group Shown Discrepancy also reported lower sleep-related anxiety and preoccupation w/ sleep, post- the intervention compared to pre-(p<.001).	Primary Insomnia (by DSM-IV)	Mini MotionLogger Actigraph Basic (AMI)	Start: 2 hrs prior to BedtimeEnd: AM Rise Time Durat: 3 consec nights x 2	Action-W	Zero-Crossing Mode; Action-W using the Cole-Kripke algorithm	Actigraphy Sleep Logs Subjective Measures	At Base (Nights 1-3), Ps overestimated their SO Lat by 37-mins and underestim TST by 46 mins. No sign Tx effects were found for either Actgraphic SO Lat or TST. All sign findings were confined to subj sleep estimates by Ps. No intrasubject statistical comparisons of subject and object SL and TST made. Low but significant correlations were observed between SDI with night TST, SE, WASO, DayTST/ NightTST ratio (r = 0.21 to 0.28). SDI was NOT associated with DayTST and 24hrTST. The highest correlations were between daily sleep quality ratings and acti for sleep efficiency (r = 0.49) and WASO (r = 0.41)	Study shows that feedback about objective sleep timing w/ actigraphy can alter the subjective perception of sleep.
{Tractenberg, 2003 #652}	3	This study sought to validate the Sleep Disorders Inventory (SDI) as a novel instrument for use in assessing and quantifying sleep disturbance/disorder in Alzheimer's Disease patients. This study was a post hoc analysis of baseline responses to the SDI in a trial of melatonin for the treatment of sleep disturbances in patients with AD	Enroll:157 Compl:104	NS	51%	75.5+/-8.6	This study provides initial validation data for the SDI as a tool to assess and quantify sleep disturbance in patients with suspected or probable Alzheimer's Disease.	Possible or probably Alzheimer's Disease, per NINCDS-ADRDA criteria	Actiwatch AW64 (Mini-Mitter)	Start:NS End:NS Durat: Actigraphs were worn continuously throughout the 2- to 3-week screening period and the 10-week protocol.	Data gaps in a 24-hr period resulted in that segment being deleted. Single actigraphic record put together for entire 8 week treatment period. Noon to noon segments were created by the analysis program.	Actiwatch AW64 series sleep-algorithm	Caregiver Logs Sleep Disorders Inventory (SDI)	Low but significant correlations were observed between SDI with night TST, SE, WASO, DayTST/ NightTST ratio (r = 0.21 to 0.28). SDI was NOT associated with DayTST and 24hrTST. The highest correlations were between daily sleep quality ratings and acti for sleep efficiency (r = 0.49) and WASO (r = 0.41)	Acti is more closely associated with daily caregiver ratings of sleep quality than retrospective ratings of sleep quality in patients with PRAD and sleep disturbance.
{Tuisku, 2003 #1007}	3a	To determine if lower limb movement recorded with actigraphy would distinguish pts with RLS from normal controls	Enroll:NS Compl:39	15	6.60%	RLS 50.3 ± 11.2 (26-62), controls 49.3 ±6.7 (33-57)	Nocturnal motor activity per minute distinguished pt from control groups more effectively than PLM Index and controlled rest during sitting test	RLS	NS	Start: End: Durat: over-night	Digital integration method of the PAM-3 (software used)	NS	Subjective Measures	Comparison to reference standard 1. Nocturnal activity distinguished patient and control groups, with RLS pts having significantly more motor activity at night than control subjects 2. RLS pts also exhibited more motor activity during sleep latency and during sleep than control subjects	
{Tuisku, 2005 #1002}	4b	To evaluate the effect of pramipexole on RLS through measurement of ankle actigraphy.	Enroll:15 Compl:	NS	1/15=7%	50.3+/-11.2	Nocturnal lower limb activity and controlled rest activity decreased significantly during the intervention in parallel with the subjectively reported relief of RLS sxs.	RLS	PAM3 (IM Systems, Baltimore, MD)	Start: ns End:ns Durat: "actometric measurements and subjective assessments were performed before and during the pramixpexole intervention, with 3-day interval in between"	Waist monitor served as a reference to control for gross movements	PAM3 software	Subjective Measures	Demonstrated ability to detect significant difference between groups or conditions in well-designed trial Significant correlation between the decrease in nocturnal activity and subjective improvement in VAS scores (r=0.44, p=.05)	
{Tworoger, 2005 #1363}	4b	This study describes objective measurement of sleep and subjective sleep quality in young adult women	Enroll:73 Compl:58	NA	NA	30.6 ±5.3 (20-40)	1. Sleep measures during the leutal phase of the cycle vary widely in women aged 20-40 sleeping at home 2. Sleep times were varied, with 26 min later bedtime on weekends 3. Perceived stress was associated with poorer subjective sleep but not objective recordings of sleep 4. Self-reported poor sleep not associated with BMI, menstrual cycle length or exercise	Healthy women during luteal phase of cycle	Acti-watch 16 (MM)	Start: End: Durat:nightly for 10 (2 periods of 5 nights)	homegrown	Cole et al (1992) and validation data supplied by MM	Subjective Measures	There were low interclass correlations for TST, time in bed, and sleep onset, but high ICC for sleep efficiency and total wake time Sleep efficiency had highest ICC across time2	One night of actigraphy data was unreliable for measuring total sleep time, sleep onset, and time in bed (intraclass correlation < or =.15) but was acceptable for measuring sleep efficiency and total wake time (intraclass correlation [ICC]=.52). Actigraphy is feasible for measuring sleep, but multiple recording nights may be needed to obtain reliable estimates.
{Uchiyama, 2002 #1349}	4b	This study aimed to clarify the phase angle between sleep propensity and the circadian pacemaker in patients with non-24-hour sleep-wake syndrome. Five patients with non-24-hour sleep-wake syndrome and 15 age- and gender-matched controls were studied.	Enroll:5 Compl:5	15	Int: 80% Cnt: 80%	Int:26.6 ± 8(16-39) Cntrl: ns ± ns (19-35)	The period of the sleep-wake cycle observed at home was longer in the non-24hour sleep-wake syndrome group (25.12hrs) than in the controls (24.02hrs) (p<.0001) (measured by actigraphy). The interval from sleep propensity onset to the melatonin midpoint was significantly shorter in the non-24 patients than in the controls, while the interval from the melatonin midpoint to the sleep propensity offset was significantly longer in the non-24 patients than in the controls.	Non-24-hour sleep-wake syndrome, per 1997 ICSD criteria	Actigraph (AMI)	Start: ns End: ns Durat: 14 days	Actigraphy derived sleep onset from the 8-10 days prior to the laboratory admission was used to estimate sleep onset. Two blinded raters determined sleep onset and offset times.	Action3	Sleep Logs	Demonstrated ability to detect significant difference between groups or conditions in well-designed trial The period of the sleep-wake cycle observed at home was longer in the non-24hour sleep-wake syndrome group (25.12 ± .18hrs) than in the controls (24.02 ± .02hrs) (p<.0001). The habitual sleep length was significantly longer in the non-24 pts (9.58 ± .60) than in the controls (7.33 ± .31).	
{Vallieres, 2003 #758}	2	This study tested the utility and sensitivity of actigraphy as an outcome measure for treatment of insomnia	Enroll:17 Compl:17	NA	41.20%	41.6 ± 5.7 (34-50)	Treatment effects were detectible using all three measures	insomnia	Individual Monitoring Systems (actigraph)	Start: End: Durat: 4 nights	IM systems software	NS	PSG Sleep Logs	1. TST and SE were similar for the 3 measures, but acti closer to PSG than sleep logs. 2 Compared to PSG, both actigraphy and sleep logs overestimated total wake time 2. Compared to PSG, acti underestimated SOL and sleep logs overestimated it.	Acti more similar to PSG than sleep logs in subjects w/primary insomnia. Also sensitive for detecting the effects of tx on some parameters.
{Van der Heijden, 2005 #684	3	To investigate whether ADHD-related SO insomnia is a circadian rhythm disorder, actigraphic estimates of the sleep-wake rhythm and salivary DLMO were compared in ADHD kids w/chronic SO insomnia and a group of ADHD kids w/ no sleep probs (controls). All were free of any psychotropic med hx. (Study was part of an ongoing randomized, placebo-controlled clinical trial of melatonin tx for chronic SO insomnia in ADHD.)	Enroll: 87Compl: 87(actigraphic data on 66)	33 ADHD w/ no SO insomnia(actigraphic data on 20)	76%-ADHD w/ SO Insomnia7 9%-ADHD contrs	8.8 +/- 1.7 yrs-ADHD w/ SO Insomnia8.2 +/- 2.0 yrs-ADHD contrs	SO was ~1 hour later (21:38 +/- 0.54 mins) w/ wake-up times ~33mins later (7:29 +/- 0.39 mins) in ADHD kids w/ SO insomnia compared to the SO (20:49 +/- 0.49 mins) and wake-up times (6:56 +/- 0.46 mins) of the ADHD contr kids.	Attention-Deficit/Hyperactivity Disorder (ADHD) by DSM-IV w/ or w/out SO insomnia	Actiwatch (Cambridge, Neurotechnology)	Start: NSEnd: NSDurat: 7 days	Actiwatch Software (Cambridge, Neurotechnology)	Validated for sleep parameters(Kushida et al, 2001,Sleep Med 2(5):389-396); rhythm parameters (Van Someren et al, 1999, Chronobiol Int, 16(4): 505-518)	Sleep Logs Subjective Measures	The mean SO (p<.001)and Wake-up times (p<.002) were sign later as was the DLMO (p<.001) in the ADHD kids w/ chronic SO insomnia (20:32 +/- 0:55 mins) compared to the ADHD contrs (19:47 +/- 0:49 mins).	Later bedtimes and waketimes are paralleled by later DLMO in children with ADHD
{Wee, 2004 #1282}	4b	To determine whether the type of ophthalmic disease (visual impair w/ optic nerve disease vs an intact optic nerve) in Blind teens is predictive of sleep/wake disturbances. A normal sighted control group was employed.	Enroll: 25 Compl: 25	12	Sex- NS	(12-20 yrs for all 37 Pts/S's) 16 +/- 1.9 yrs-Blind w/ optic nerve disease 15.9 +/- 2.4 yrs-Blind w/ intact optic nerve 16.5 +/- 2.9 yrs-Sighted Controls	Only presence or absence of optic nerve dis was a sign predictor of daytime napping. Blind teens w/ optic nerve disease (8 of 11) were 9.1-times more likely to nap >20-mins daily compared to blind teens w/ intact optic nerves (3 of 14, p=.02) and 21.3-times more likely than sighted teens (only 1 of 12, p=.04).	Visually Impaired teens w/ or w/out optic nerve desease	Actiwatch-L (Mini)	Start: NS End: NS Durat: 14-days	Automated analysis w/ Actiware (Mini))	Actiware (Mini)	Sleep Logs Subjective Measures	The SD of the wake-up times across 14-days of actigraphy was used as the measure of Wake-up Time Instability. The blind Ss w/ optic nerve disease had >Wake-up Time Instability compared to either blind Ss w/ intact optic nerves or the sighted contrs (p=.02).	Detection of daytime napping and wake time instability in young subjects with visual dysfunction.
{Wilson, 2004 #745}	1	This study, using a double-blind cross-over design, evaluated if actigraphy could be used detect changes when pts were treated with temazepan, and to determine if an automated method of questionnaire data collection would be comparable with traditional data collection methods	Enroll:NS Compl:38	0	NS	NS	1. the majority of pts preferred to use the telephone system (22/38) of data collection. There were no significant differences in scores when responses on paper and pencil questionnaires were compaired to automatic telephone data collection 2. Significant effects were noticed on both subjective and objective measures with temazepan between treatment and placebo weeks	insomnnia	Cambridge Neurotechnology, Actiwatch	Start: End: Durat:5 weeks	Software plus non-parametric analysis of rest activity patterns		Subjective Measures	Actigraphy showed significant treatment effects for hypnotic use (TST, immobility, fragmentation index). Low correlation between fragmentation index and subjective sleep quality (St. Mary's Hospital Sleep Questionnaire)	Both acti and subjective reports showed signif tx effects, but the subjective effects were greater in magnitude and lasted longer in patients w/ insomnia.
{Winkler, 2005 #682}	3	To investigate if Bright Light Tx (BLT) reverses the abnormalities of the circadian rest-activity cycle that tend to accompany SAD. A sex and age matched control group of normal Ss was included.	Enroll: 17 Compl: 17	17	24%	36.9 +/- 13.5 yrs	SAD Ps had a 6% attenuation of the amplitude of the activity-rest cycle (p=.025) which was phase delayed by 55-mins (p=.023) compared w/ controls at Week 1. BLT in SAD Ps resulted in an incr of relative ampli (p=.005) from Week 2 on and an advance of the activity-rest cycle in Weeks 3 and 4 (p=.036). At week 4, there were no longer sign group diffs. Intradaily stability (coupling of activity to external zeitgebers) incr by 9% in both patients and healthy contrs by the 4th week (p=.032).	Seasonal Affective Disorder (SAD) – w/ fall-winter depression (by DSM-IV-TR)	Actiwatch Plus (Cambridge Neurotechnology Ltd)	Start: NS End: NS Durat: 4-weeks	Actiwatch Sleep Analysis 2001 software, Ver 1.19. Sleep analysis used a Medium Sens to estimate actigraphic sleep parameters	Total daylight and dark activity, derived from actual sunrise/ sunset times in Vienna; Cosinor analysis	24-hr Actigraphy Portable Light Boxes Sleep Logs Subjective Measures	Comparison to reference standard SAD Ps had 43% lower daylight activity (p=.006), 33% lower total activity (p=.031), and a lower Sleep Eff% (p=.030) compared to contrs in Week 1, all of which incr sign after 4 weeks of BLT. After 4 weeks of BLT, no sign diffs were found betw SAD Ps and control Ss on activity measures.	
{Wolfson, 2003 #663}	2	To examine the validity of self-reported survey estimates of sleep patterns in adolescents using a comparison of retrospective (2-weeks) descriptions of sleep patterns w/ sleep diary reports and actigraphically estimated sleep parameters over a subsequent week.	Enroll: 302 Compl: 302	NA	35%	16 +/- 1.2 yrs (13.8 – 19.9 yrs	Survey estimates of TST and Wake-times were w/in 5-mins of those reported in diary and estimated by actigraphy. Bedtimes were 8-13-mins earlier than diary or actigraphy estimates. Ss reported sleeping ~30-mins longer on weekend nights compared to diaries or estimated by actigraphy. Survey reported weekend Wake-times were ~55-mins later compared to diaries or actigraphy estimates.	Adolescents	Mini MotionLogger Actigraph (AMI	Start: NS End: NS Durat: 8 days	Action-W2 software (AMI)/Custom-Acebo et al, 1999, Sleep,22:95-103;	Zero-Crossing Mode; Actigraphic Scoring Analysis ("Sadeh" algorithm)	24-Actigraphy Sleep Logs Subjective Measures	Survey reports of school and weekend night sleep behaviors were sign corr w/ both acti. The strength of the associations were consistently greater for school night variables compared to the corresponding weekend night variables.	In adolescents, the highest association between survey data and acti was for wake-time during the week (r = 0.77), followed by bedtime and sleep duration. The lowest correlation was for weekend sleep duration (r = 0.31).
{Yaron, 2004 #643}	4b	To evaluate the effect of rapid ascent to moderate altitude on sleep (actigraphy and logs) in infants and pre-verbal children. (Part of a larger study to examine the effects of acute high altitude exposure.)	Enroll: 37 Compl: 30	NA	43%	(4-33 mos) 19.5 +/- 10.8 mos-girls 13.9 +/- 8.5 mos-boys	Sleep patterns among infants/toddlers were sign disturbed (by inference from increased motion/activity counts across the nocturnal sleep period) during the 1st night after ascent to a moderate altitude (3109 m). This effect was acute, and activity levels were returning to baseline altitude levels already by the 2nd night after ascent.	Infants/toddlers (4 to 33 mos)	Mini-MotionLogger (AMI)	Start: NS End: NS Durat:7-days total (1-4 and 5-7 were contiguous)	Presume AMI but NS	Threshold used for activity counts but NS	24-hr Actigraphy Sleep Logs Subjective Measures	Sign incr in activity counts during the sleep period occurred for the 1st night after ascent to 3109 m compared to baseline altitude (1610-1645 m) at home or in a hotel. Activity during sleep was already decr back towards baseline levels by the 2nd night of altitude ascent.	Altitude-induced disruption of sleep documented by an increase in activity counts in young children.
{Zucconi, 2003 #759}	2	Dose-finding study to determine if cabergoline reduces symptoms of RLS in patients with moderate to severe symptoms	Enroll:12 Compl:10	0	68%	56.6 (38-73)	Cabergoline significantly reduced symptom severity compared to placebo as measured by IRLLSSG Rating Scale and Clinical Global Impression Scale. Mean motor activity as measured by actigraphy also decreased significantly	RLS	Am MotionLogger	Start:NS End:NS Durat: 4 nights (baseline, T), T1, and T2)	NS	NS	PSG Subjective Measures	Blind, prospective comparison to reference standard Mean motor activity (as measured by actigraphy) decreased with treatment	