# Validation with Polysomnography of the Sleepwatch Sleep/Wake Scoring Algorithm used by the Actiwatch Activity Monitoring System

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## Introduction

The Actiwatch Activity Monitoring System relies on the wearing of a very small unobtrusive actigraph unit on the wrist to monitor activity levels (intensity and duration) over set periods to determine sleep-wake episodes and activity profiles. By use of a Windows-based software program, Sleepwatch, predetermined epochs (15 seconds to 2 minutes) can be scored for sleep or wake in periods set by the user. In this way a series of measures for each consolidated sleep episode can be determined. These include parameters also measured by polysomnography such as total sleep and wake times, as well as other movement parameters. The software uses an algorithm based on preset criteria (see handbook for further details) to determine sleep or wake for each epoch and displays them both graphically and in table form. All subsequent data can be printed out and exported to a spreadsheet for further analysis and summarisation if necessary.

The following is a summary of the validation of the Sleepwatch sleep scoring algorithm with polysomnographic scoring of wake and sleep episodes in normal control individuals. This data represents only some of the information available due to the reluctance of other centres to release such information at this time for public dissemination. The data presented is from 11 subjects.(all male age 23 to 67) from 2 sites viz the University of Surrey, England (Dr Stephen Deacon) and Northwestern University, Illinois, USA (Dr Phyllis Zee).

#### Methods

Both study centres used various Actiwatch models, together with the Sleepwatch analysis software program. The sensitivity level was the at the 'Medium' preset level. Simultaneous Polysomnographic recordings were made using the Oxford Medilog 2000 or 3000 series and standard EMG monitoring equipment.

#### Results

Of the 17 parameters which are scored by Sleepwatch, it shares four which are also measured by all polysomnographic techniques. It is a comparison between these four measures (sleep time, WASO (wake after sleep onset), sleep efficiency and sleep onset latency) which are used as a basis of the data produced in this report. The extra parameters measured by Sleepwatch (e.g. movement and fragmentation indices, bout durations etc.) are not measured by polysomnography and thus cannot be directly compared.

The comparison data is shown in two tables set out below.

	Median Difference	IQ Range
Sleep time (mins.)	8	5.5 - 12.5
WASO (mins)	4	0 - 16.0
Latency to sleep onset	2	0 -140
(rains)		
Sleep Efficiency (%)	1	1 -3.5

**Table** 1. The Median differences with Interquartile (IQ) ranges of values obtained for four sleepwake measures scored simultaneously with polysomnography and Sleepwatch software on Actiwatch - derived data. N = 11. WASO - Wake after sleep onset. Sleep Efficiency = Sleep time/Time in bed.

The differences seen in the Table 1 reflect both directions in that in some instances Sleepwatch gave a value higher than polysomnography for example and sometimes the reverse was true.

	Sleepwatch (Actiwatch)		Polysomnography	
	Mean	SEM	Mean	SEM
Sleep time (min)	417.09	17.97	425.27	18.99
WASO (min)	20.64	3.79	21.18	4.78
Latency (min)	18.73	3.81	22.55	3.05
Sleep Efficiency	89.60	1.29	89.00	1.53
(%)				

Actual values of the four measures obtained were remarkably similar as shown by Table 2 below.

**Table** 2. Mean and Standard Errors (SEM) of values obtained for four sleep-wake measures scored simultaneously with polysomnography and Sleepwatch software on Actiwatch - derived data. N = 11. WASO - Wake after sleep onset. Sleep Efficiency = Sleep time/Time in bed.

From Table 2 it is clear that the data obtained is very consistent (in some instances exact value matches were obtained) between Sleepwatch and polysomnographic - derived values, and that there is no difference between the two.

## Discussion

From the data presented above, it is clear that the algorithm used by Sleepwatch software to determine sleep and wakefulness from Actiwatch - derived data has been clearly validated in control subjects. There is no statistical difference between the data obtained using the Actiwatch and that using polysomnography. Furthermore, the levels of consistency obtained with the Actiwatch are the of the same order as that seen with polysomnography.

Data is accumulating from other centres where the Actiwatch is being used to obtain data concurrent with polysomnography from subjects suffering from insomnia, sleep apnoea and PLMS (period leg movement in sleep). Preliminary data indicates that high levels of correlation can be seen with polysomnography in all instances.

In conclusion, the algorithm used by Sleepwatch software has been satisfactorily validated with polysomnographically derived sleep-wake data. Actiwatch can therefore be used with confidence to determine levels of sleep and wakefulness.