Comparison of sleep endpoints

Actiwatch Spectrum Plus and Actiwatch Spectrum PRO vs. Actiwatch Spectrum

Abstract

A comparison of the estimates of total sleep time (TST) and total wake time (TWT) measured in 156 nights, in a total of 24 healthy subjects, showed no statistically significant differences in the mean values measured by the Actiwatch Spectrum Plus and Actiwatch Spectrum PRO compared to the Actiwatch Spectrum. Differences on individual nights for TST were less than ten minutes for 98.7% of the nights and for TWT differences were less than five minutes for 99.3% of the nights. This demonstrates very good "backward compatibility" between the two devices.

Bland-Altman analyses showed no evidence of any systemic differences in raw activity counts as a function of activity values or TST as a function of TST values. Bland-Altman analysis of TWT showed a very modest difference of -2% which does not manifest itself in the overall comparison.

Introduction

The Actiwatch Spectrum has been in use for more than five years and has provided researchers and clinicians with valuable measurements of sleep quality and duration. In 2013, Philips Respironics introduced the Actiwatch Spectrum Plus and Actiwatch Spectrum PRO devices which have the same form as the Actiwatch Spectrum, but have some additional features including a rechargeable battery and larger memory.

The Actiwatch Spectrum PRO also allows recording of two subjective endpoints on a numerical scale. The Actiwatch Spectrum Plus and Actiwatch Spectrum PRO use the same MEMS type accelerometer and record data identically. The MEMS accelerometer used for these devices is different from the piezo type accelerometer in the Actiwatch Spectrum. The MEMS type accelerometer is the same type of technology used in modern smart phones. This difference raises the possibility that sleep endpoints calculated from data obtained from the newer version of Actiwatch may be different from those obtained from the Actiwatch Spectrum. If steps were not taken, this difference would create a problem for researchers wanting to compare data from the two devices. To address this issue, the firmware of the Actiwatch Spectrum Plus and Actiwatch Spectrum PRO has been designed so the counts/minutes they provide mimic the values that would be obtained from the Actiwatch Spectrum device.

This report describes the results from a study comparing the two devices to quantify the degree of "backward compatibility" of sleep endpoints between the Actiwatch Spectrum Plus and Actiwatch Spectrum PRO with the Actiwatch Spectrum.

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Methods

A convenience sample of 24 healthy volunteers was asked to wear the Actiwatch Spectrum PRO and the Actiwatch Spectrum on their non-dominant wrist for seven days and nights. The two devices were strapped on top of each other and attached to one wrist band. The Actiwatch Spectrum was on top for half of the data collections sessions and on the bottom for the other half.

The actigraphy data were analyzed with the Philips Respironics Actiware software (version 6.0) to determine the estimates of total sleep time (TST) and total wake time (TWT) each night. Data was considered for comparison when sleep intervals as determined by the software were at least four hours in duration but did not exceed ten hours. Additionally, these sleep intervals must have been located within a period of low subject activity indicating an interval of rest that did not exceed 11 hours.

The two devices were to be considered backward compatible if the mean values of TST and TWT across the population were not significantly different from each other ($p>0.05$ by paired t-test). Additional descriptive analyses included comparison of the counts/min values and Bland-Altman plots for TST and TWT to look for systemic differences and measures of the magnitude of differences between the devices on individual nights.

Results

Acceptable data were obtained from comparisons for 156 of the 168 possible nights. The primary reason for exclusion was the removal of devices for some nights resulting in the absence of useful data. A regression line of the counts/min data for each subject across all available nights was calculated for each subject. The mean slope (new device/old device) of those lines was 0.96 ± 0.06 (s.d.) with a range of 0.85 to 1.07. The mean slope of the counts/min data in Bland-Altman plots for each subject was 0.004 ± 0.024 (s.d.) which was not significantly different from zero.

Table 1 shows that the difference between the two devices for the overall mean values of TST and TWT was 1.6 minutes which was not statistically significant in either case.

Table 1. Overall summary statistics

	TST (min)	TWT (min)
Number of nights	156	156
Mean ± s.d.		
Actiwatch Spectrum	401.1 ± 72.8	34.4 ± 20.0
Actiwatch Spectrum PRO/Plus	397.6 ±73.0	35.7 ±20.2
Mean difference (AW Spectrum PRO-legacy)	1.6 ± 5.1	-1.6 ± 1.5
P value of differences	>0.67	>0.58

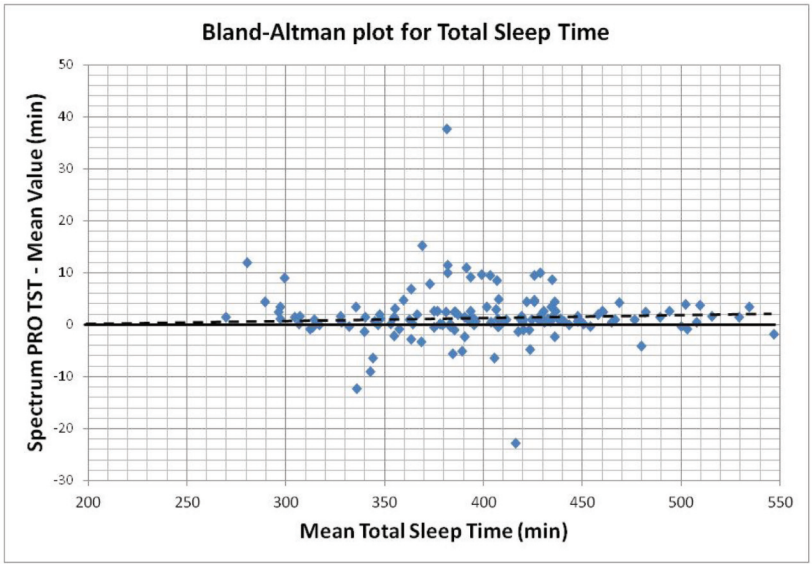

Figure 1

The individual night differences between TST values from the Actiwatch Spectrum and Actiwatch Spectrum PRO and the mean TST of both devices were less than ten minutes for 98.7% of the nights. The difference was less than 5% in 99.3% of the nights. Figure 1 is the Bland-Altman plot showing these differences as a function of the mean TST value. The regression line (dashed line) through the data had a slope of 0.03 ± 0.003 which is not significantly different from zero ($p>0.35$).

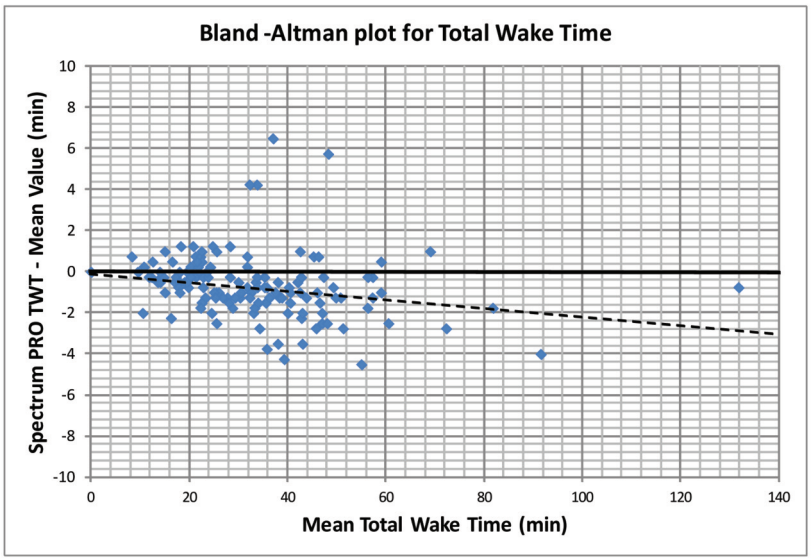

Figure 2

The individual night differences between TWT values from the Actiwatch Spectrum Plus and Actiwatch Spectrum PRO and the mean TWT of the two devices worn were less than five minutes for 98.7% of the nights. The difference was less than 5% in 82% of the nights. Figure 2 is the Bland-Altman plot showing these differences as a function of the mean TWT value. The regression line (dashed line) through the data had a slope of -0.022 ± 0.006 which is significantly different from zero ($p>0.01$).

Discussion

The Actiwatch Spectrum Plus and Actiwatch Spectrum PRO are backward compatible with the Actiwatch Spectrum for estimates of total sleep time as shown by very close agreement between the overall and individual values for each night. Furthermore, there is no evidence of any systematic difference between the two as a function of TST values as shown by the Bland-Altman plot.

The two devices are also backward compatible for total wake time as shown by the close agreement between the two devices for this endpoint. There is evidence, however, to suggest that the Actiwatch Spectrum Plus and Actiwatch Spectrum PRO may underestimate the Actiwatch Spectrum value of TWT by a systematic error of 2% or one minute in a night with 50 minutes of wake time. This difference may have little practical significance because it did not manifest itself in the overall results which showed a mean TWT value that was higher (rather than lower) for the Spectrum Actiwatch Spectrum Plus and Actiwatch Spectrum PRO versus the Actiwatch Spectrum (Table 1).

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