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Activity in the Chronically Critically Ill

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Abstract

Although therapeutic activity prevents functional decline and reduces mortality, little is known about typical levels of activity among intensive care unit (ICU) patients. This report of a preliminary study describes typical therapeutic activity and compares the use of two measures of activity in a small sample of chronically critically ill adults. Type, frequency, and duration of therapeutic activity were measured simultaneously with direct observation and actigraphy. The only consistent activity documented was turning (frequency: 3 turns/8 hours; duration: mean average of 11 minutes). Analysis demonstrated acceptable agreement between the two measures of activity for both frequency and duration of therapeutic but not for type of activity. Congruence between measures for duration of activity was also supported. This study provides information for investigators and practitioners who are interested in measuring or implementing therapeutic activity in selected critically ill adults.

Keywords

Activity; ICU; Critically ill patients; Chronically ill patients; Actigraphy

INTRODUCTION

Clinicians advocate introducing activity early in an acute illness to promote patient comfort, improve sensory stimulation, and prevent complications of bedrest.[1-3] Yet there are many contraindications and precautions to activity in the intensive care unit (ICU) and bedrest remains a common prescription.[4-6] There is limited information about the optimal type of activity to benefit critically ill patients, especially patients who become chronically critically ill while hospitalized. There are no published studies that detail the typical duration and frequency of activity in critically ill patients. This report describes typical therapeutic activity and compares the use of the direct observation and actigraphy to measure the activity in a sample of chronically critically ill adults. Chronically critically ill adults are defined as ICU

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patients who have stabilized after an acute illness but remain mechanically ventilated for more than 3 days [7,8]

BACKGROUND

Therapeutic activity refers to the *beneficial* alteration or regulation of the physical status of the body.[6,9,10] In community-dwelling adults, therapeutic activity, sometimes labeled as mobilization, promotes physical fitness, prevents disability, and slows the onset of degenerative processes.[3,6,11] Therapeutic activity in the ICU frequently begins with turning the patient from supine to lateral positions and initiating range of motion (ROM) exercises that may progress to dangling, chair sitting, and ambulation. Therapeutic activity can also be initiated and maintained by the ICU patient and includes self-adjustment and self-comforting movements, such as using the incentive spirometer, completing ankle exercises, or pulling covers up for warmth.

> Therapeutic activity refers to the beneficial alteration or regulation of the physical status of the body.

Chronically critically ill patients are at risk for developing complications associated with prolonged hospitalization and bedrest, yet there is limited information about the role of activity in preventing these complications. Studies have investigated in-bed turning/positioning, sitting, and ambulation as therapeutic activities in ICU settings.[12-18] Much of the information about benefits of activity for critically ill patients is based on observations of a single body system response, such as cardiovascular or respiratory parameters. Additionally, critically ill participants in previous research typically have a common diagnosis such as unilateral lung disease or post-coronary artery bypass graft surgery. There are no published studies that detail common therapeutic activities experienced by the ICU patient, the frequency of activity, or the duration of activity in the ICU. In addition, there is no standard for measuring activity and there is limited information about the utility, reliability, and validity of different approaches to measuring activity in the ICU; most measures focus on rest or inactivity.[19-21]

PURPOSE

Given the lack of empiric support, this exploratory study was developed to describe typical therapeutic activity and compare the use of the direct observation and actigraphy to measure the activity in a sample of chronically critically ill adults. Chronically critically ill patients are at risk for developing complications associated with prolonged hospitalization and bedrest.

THEORETICAL FRAMEWORK

Creditor's Hazards of Hospitalization Framework provides an organizing framework for this study, illustrating the interaction of hospitalization and bedrest, which leads to multiple adverse outcomes.[3] Although Creditor explicitly relates his framework to the elderly, it is useful here as the framework includes relevant concepts and the average reported age of the chronically critically ill is over 60 years.[4,7,22] Creditor's Model suggests that therapeutic activity can be used to prevent a variety of complications and adverse outcomes related to prolonged hospitalization and associated bedrest. Therapeutic activity was defined as purposeful movement that does not injure the patient or create an unsafe condition and provides a beneficial alteration of the physical status of the body.[6,9,10] In this study, therapeutic activity included turning, ROM, dangling, chair sitting, ambulation, and other.

METHODS

This was a descriptive, exploratory study extending a larger study investigating weaning from prolonged mechanical ventilation. Therapeutic activity was the focus of this substudy. Two measurement approaches were selected as most likely to indicate therapeutic activity in the ICU setting: logged observations and actigraphy.[20,21] All data were entered into a spreadsheet and analyzed using SPSS 11.0 and MedCalc 7.4.

Setting and Sample

This study was conducted in a Midwestern academic medical center. None of the ICUs at this institution have a physical therapist dedicated to the ICU. A purposive sampling plan was used in an attempt to include participants with the potential for a variety of therapeutic activities. A sample size of 20 participants was chosen for this descriptive study to allow for sufficient power to detect congruence between the two measures using Bland-Altman plots (http://www.medcalc.be, accessed January 21, 2004). Twenty participants were recruited; no one approached declined to participate in this study. The investigators received approval from the hospital's Human Subject Review Board before any participants were enrolled into the study. All participants, or their designees, provided informed consent.

Inclusion criteria for participation in this pilot study included physiologic stability and an ICU stay of 5 to 15 days. Physiologic stability was defined as no recent surgery, cardiac, or respiratory emergency or any other event considered compromising the patient's status in the 24 hours preceding data collection; bedside nurse, physicians, and records were used to evaluate the presence of this inclusion criterion by the data collector. Patients with neurological or neuromuscular diagnoses that precluded activity (such as quadriplegia or stroke) were excluded from enrollment. No participants were physically restrained during observation periods. Three lightly sedated patients were included as both turning and ROM were incorporated in their plan of care.

Demographic Characteristics

The sample consisted of 20 purposively selected participants who met inclusion criteria. Nineteen participants completed the study; one subject transferred out of the ICU before a second 4-bour observation period could occur; 4 hours of data from this subject are included in this analysis. Demographic characteristics of all participants are summarized in Table 1. In general, patients were observed during their 10th day in the ICU with a mean Motor Assessment and Activity Scale (MAAS) score of 2.7 (SD ±0.63), indicating a state of calm cooperation. All participants were able to initiate activity; commonly self-initiated activity consisted of small bead, hand, and leg movements.

Procedures

Actigraphy devices were placed on the subject's wrist over a protective cotton stretch band. In general, the dominant arm was used when placing the device to measure the greatest amount of activity. In 4 patients., the nondominant arm was used when staff suggested that the device might interfere with the intra-arterial and intravenous catheters and tubing. Actigraphy devices were worn for 24 hours and during that time a member of the research team would schedule 2 separate 4-bour observation periods. A variety of 4-bour blocks of time over different days of the week and at different times of day in this study were sampled in order to be able to describe typical activity over a 24-hour day, 7-day week of hospital care.

Data were collected using chart abstraction (demographic and illness-related variables of age, gender, race, sedation status, APACHE 3 score on admission to ICU, admitting/primary diagnosis, length of ICU stay, length of hospital stay, and duration of mechanical ventilation), logged (direct) observation, and actigraphy. These data were collected to ensure a heterogeneous sample and to detail characteristics of this chronically critically ill sample.

After ensuring that the actigraphy device was placed correctly, the data collector obtained an optimal position for observation that did not interfere with the subject's privacy or the staffs ability to complete tasks. During observation, the data collector remained in the patient room or at the door of the room and scanned continuously, recording observations about subject position and movement as they occurred. Staff were aware of the purpose of tbis study; no one indicated that they altered the type or amount of activity provided to the subject as a result of direct observation.

Instruments

Demographics: Chart abstraction data were obtained retrospectively from the larger study's database, which required a greater than 90% interrater reliability for abstraction and data entry. All other data were collected prospectively.

Observation Log: The observation log was developed specifically for this pilot study and designed to record changes in body position and body movement over a 4-hour period. Three expert nurses examined the tool for appropriateness, accuracy, and representativeness of activity in ICU patients. The log was used to record type, frequency, and duration of activity. The log bad 2 components: (1) the MAAS[23] to record baseline subject activity and (2) space to record observations for therapeutic activity (Figure 1). The exact time (to the second) was recorded for all observations. Two different nurses collected log data. Interrater reliability was 90% agreement between the data collectors prior to the start of the study and at midpoint (subject 10). Each subject had 2 logs for a total of 8 hours of direct observation, one for each 4-bour period. Activity was sampled continuously; the data collector was in the same room as the subject. The limit of 4 hours for observation was selected from previous research reports to minimize observer fatigue.[20,21,24]

Actigraphy and Motionlogger™: Actigraphs are electronic devices that sense, count, and record movement.[21] Several devices are commercially available. The wrist-worn Motionlogger™ was used for this study. This actigraphy device contains a free-moving electrical transducer that generates voltage that is proportional to acceleration, the physical force generated by movement. The transducer continuously detects and stores acceleration as movement in more than one direction. One-minute intervals of time were used to mark onset and cessation of activity. Data from the device are accessed through an interface that connects to an IBM-compatible personal computer. Action Software™ converts stored information about voltage changes from the actigraphy device into graphic and analog data. The Motionlogger™ device and software assess both the intensity and quantity of activity (http://www.ambulatory-monitoring.com, accessed November 16, 2003). Reliability and validity of the Motionlogger™ are well established. Values obtained during calibration of the actigraph result in variation of 10% or less; test-retest of the device with a pendulum yields Pearson coefficients of 0.97 to 0.99.[25] Correlations with oxygen uptake, heart rate, and self-report measures of activity range from 0.71. to 0.84 and activity counts are reported as significantly different between sedentary and aerohic tasks ($F_{2,28} = 108.7$, $P < .0001$).[21,25] Activity is recorded in 3 modes, described below.

The Proportional Integrating Measure (PIM) mode indicates the extent of a rhythmic change or range of activity. The amplitude of the voltage generated by movement is measured proportionally to the rate of change of acceleration. Thus, the amplitude or intensity of motion can be examined with data from the PIM mode; intensity was expected to suhstitute for types of activity. The Motionlogger™ does not have a mode to categorize the type of activity. However, we expected that similar activities would result in similar graphic patterns in the

PIM mode. Specifically, turning was expected to be low intensity and that ROM, chair sitting, and ambulation activities would be recorded as progressively greater intensity and PIM values.

The Motionlogger™ quantifies activity through its Zero Crossing Mode (ZCM) and time above threshold (TAT). Movements are counted in 1-minute epochs and movement must generate a change of 26 μV in order to be counted. The standard threshold of 26 μV is used to eliminate high-frequency movements from tremors or vehicle motion. Prior to the start of the study, the Motionlogger™ devices were calibrated by the manufacturer to ensure precision.

The TAT data express the percent of time above threshold or the duration of activity. In this mode, movement must be sustained for at least 100 milliseconds to be counted as movement. For each minute, 600 episodes are sampled. Therefore, a TAT of 300 indicates that 50% of the sampled time—30 seconds—is above threshold. The TAT scores were used to quantify duration of time spent in activity.

The ZCM mode is essentially a movement detector. It is converted to a value when activity is detected (ie, the number of times acceleration goes either above or below threshold}. Software for Motionlogger™ uses the Cole-Kripke formula to calculate mean activity events per minute (http://www.ambulatory-monitoring.com, January 16, 2004). The ZCM values were used to calculate the frequency of activity.

Data Analysis

Demographics were reported as means for continuous data and frequencies for categorical data. The type, duration, and frequency of therapeutic activity were summarized by descriptive statistics. The comparison of measures used percent agreement and Bland-Altman plots.

Actigraphs (Figure 2) were compared with direct observations to calculate the percent agreement. Spikes in the PIM mode were labeled with the type of observed (logged) activity. If time of onset and cessation of activity were congruent, then agreement was scored as one (1). If there was disagreement, the graphic was scored as zero (0). Percent agreement was then calculated by adding the number of agreements (scored as one) over the total possible number of agreement points. Only the principal investigator calculated percent agreement; intrarater reliability was maintained at 95% agreement by re-examining every 10th record 4 weeks after the original analysis.

Bland-Altman plots were constructed to examine congruence between logged observations and actigraphy data for frequency and duration of activity (MedCaic software, http://www.medcalc.be).[26,27] A Bland-Altman plot is a method to assess agreement between 2 clinical measurements. The differences between 2 measures are plotted against the mean of the 2 measurements, yielding a scatter diagram, which identifies outliers and illustrates the size of each difference, the range of differences and their distribution about zero (indicating perfect agreement). For our study, the frequency of activity measured by the ZCM mode was compared to the number of logged activities. Congruence for duration of activity was also examined with TAT values and total time of logged activities.

RESULTS

Descriptive Analyses

Table 2 summarizes the type and frequency of activity using both logged and actigraphy data.

Type of Activity: The most common observed therapeutic activities were turning and ROM. Eleven participants experienced some ROM during the 8 hours of our observation. Only 2 participants sat in a chair. One episode of standing, but none of dangling or ambulation, was observed. Therapeutic activity was most often initiated by a nurse: 75% of therapeutic activities or 147/196 of total observed activities.

The most common observed therapeutic activities were turning and ROM.

Frequency of Activity: All participants experienced 3 or more turns when in the bed during our hours of observation. No subject experienced more than one episode of ROM during observation periods. Similarly, no subject experienced more than one episode of chair sitting or standing during observation periods.

Duration of Activity: Over an 8-hour period, the time required for turning averaged 11 minutes (SD = ±6). Turning time ranged from 30 seconds for a single turn from a lateral position to a supine position to 21 minutes for multiple turns associated with hygiene and linen change. Time spent in ROM activity averaged 8 minutes (SD = 10). ROM was most likely to occur during daylight hours and was initiated by the nurse (8/11 occurrences), family member (especially hand and finger) (2/11 occurrences), or physical therapist (1/11 occurrences). Both daytime episodes of sitting in a chair lasted several hours (175 and 289 minutes) and were initiated by nursing staff.

Comparative Analyses

Type of Therapeutic Activity: Too few participants engaged in higher intensity activity such as dangling, sitting in a chair, or ambulating to analyze correlations between observed activity intensity and the PIM mode in actigraphy. Actigraph PIM data were expected to distinguish between intensity or levels of therapeutic activity. For example, it seemed reasonable to assume that sitting in a chair would show a greater intensity compared to lying in bed or turning. Anecdotally, 2 participants who sat in a chair had PIM values that were similar to participants who lay in bed with an MAAS score of 2, indicating calm cooperation (ie, responsive to touch, little spontaneous movement); chair sitting values were indistinguishable from resting in bed. We were not able to discern a pattern of intensity in the PIM values that reflected specific types of therapeutic activity such as differentiating a full lateral turn versus a half-lateral turn.

Frequency of Therapeutic Activity: The percent agreement for the frequency of therapeutic activity between the graphic recording and logged observations ranged from 40% to 100%, with an average of 76% agreement. Specifically, the Motionlogger™ graphs indicated 261 activity occurrences, although only 196 activity occurrences were observed. Most commonly, the actigraphy device recorded movement when none was observed. There were 3 instances when the actigraphy device did not record movement but turning or ROM was observed. One explanation is that the arm with the actigraphy device had minimal movement compared to other limbs and the accelerometer did not record. Figure 2 shows best and worse case scenarios with 2 actigraphs.

Bland-Altman analyses were used to compare the total frequencies of observed activity and the averaged ZCM during the 8 hours of observation (Figure 3). Bland and Altman analysis indicated a mean difference of -5 7 episodes of activity between the 2 measures, demonstrating that actigraphy overestimated the averaged therapeutic activity. This is not a surprising result in that actigraphy does not distinguish between all activity and therapeutic activity as did logged observations. The plot illustrates propottional error, with the greatest overestimation occurring when there are many activities. Because the differences between methods are large (ie, more than 30% variability; SD = 137.8 - 23.3), logged observations and actigraphy cannot be considered interchangeable approaches to measuring the frequency of activity in this sample. Duration of Time Spent in Therapeutic Activity: Digital records from the activity device were converted to seconds by actigraph software as the total time in activity (TAT). This value was compared to total activity time logged during direct observation. For all 20 participants, an average of 39 minutes of activity over 8 hours per subject was directly observed compared to a mean of 64 minutes of activity per subject recorded by actigraphy. Agreement between the 2 methods for time spent in therapeutic activity was 66% (range 40-80%). The Bland-Altman plot showed a tight cluster of agreement when the activity time is 30 minutes or less. The differences in time spent in activity between the 2 measures averaged 33.7 minutes with actigraphy recording more time spent in activity. The difference between the 2 methods of measuring duration of activity is less than 10% and for clinical measures, this proportional difference is probably acceptable. There were 3 outliers in this analysis, one of which was outside the 95% confidence interval. Additional analysis of data indicates that the 3 outliers in the Bland-Aitman graph had high MAAS scores of 4, indicating agitated movement. Actigraphy did not differentiate between random or agitated movement and therapeutic movement.

DISCUSSION

The goals of this study were to describe typical therapeutic activity and compare the use of the direct observation and actigraphy to measure the activity in a sample of chronically critically ill adults. Despite physiologic stability, participants experienced infrequent activity and short durations of therapeutic activity. Activity typically consisted of turning and ROM with only 2 participants participating in chair sitting in this setting. A reduced turning schedule (3 times over 8 hours) compared to typical recommendations of turning every 2 hours may be related to long periods of chair sitting by 2 participants.[9,28]

Limitations to this study include instrumentation, as the data collector may have become more experienced in observation over time; testing, as staff may have altered their activity interventions with subjects during observation periods; and selection, in that the chronically critically ill patients who agreed to participate may be unique in some way. Instrumentation was addressed by examining interrater reliability during the study. Several staff indicated that they did not do anything different while the data collector was present when asked directly at the end of the observation period. Finally, our sampling approach was purposive; we recruited the next patient in the larger study who met our inclusion criteria. Because no patient declined participation, we think we captured a fairly representative sample in this setting.

Both tools measured activity as movement. Logged and actigraph data were acceptably congruent for duration of activity but not congruent in measuring the frequency or type of activity. The Motionlogger™ technology does not discriminate between movements of a few inches versus a few feet. A high amplitude or intensity can be demonstrated with either large-muscle or fine-muscle movement. In this study, actigraphy did not discriminate between lying quietly in the bed and sitting quietly in a chair in a sample of 2 participants. Yet clinically, the intensity of these 2 activities is important in this patient population. For example, the oxygen demands of chair sitting are much greater than lying in bed.[12,29,30]

Frequency was most likely to have similar values in the midrange of occurrence of about 3 activities over 16 minutes (reported as 30 activities over 480 minutes in Figure 3). However, Bland-Altman results indicated that actigraphy consistently measures a greater frequency of activity than direct observation, despite an acceptable percent agreement between the 2 methods.

There was acceptable agreement and congruence in documenting time spent in activity. The greatest agreement occurred when the duration of activity lasted 1 to 10 minutes (Figure 4). The levels of agreement for both frequency and duration of activity are comparable to other reports in the literature, comparing actigraphy to biochemical markers, a diary, log, and video recording.[31-36] The proportional increase in detecting activity by the actigraphy device may be clinically significant for duration of activity; the difference between the mean values of 39 minutes of directly observed activity compared to 64 minutes recorded by actigraphy is 25 minutes per participant over 8 hours.

There was acceptable agreement and congruence in documenting time spent in activity.

Logged observations were useful, especially in detailing the exact type of activity experienced by participants and which caregiver was involved in the activity. Observing in 4-hour blocks throughout the 24-hour day was used to help identify times of day when activity was most likely to occur (unreported data) for future investigation. However, consistent sampling at specified times, especially times of high activity such as late morning or afternoon, may indicate that chronically critically ill patients experience more activity than recorded in this study. Logged observations were very personnel-intensive and the distracting environment of the ICU did not always support undivided attention to the log. Therefore, the data collector may have missed brief therapeutic activity while recording observations that occurred in the immediate past. Observer fatigue contributes to error.[24,37-39] Direct observation is also expensive for large studies.[39] Videography may address some of the shortcomings of real-time observer data collection although there may be additional legal hurdles to overcome when making a video recording in the ICU or hospital setting[35,40]

There were no difficulties using the actigraphy device in the ICU. There were no episodes of equipment failure or loss and participants did not report problems with wearing this monitoring device on their wrist. The software was user-friendly; it loaded and ran without problems. Interpreting the graphic records was no more difficult than interpreting descriptive graphs from other kinds of data. One clear advantage of actigraphy over direct observation was the reduction in data collection time. Acquiring and interpreting 8 hours of actigraphy data used considerably less time (estimated at less than 1 hour for each subject) than direct observation (estimated at 9 hours for each subject).

Based on these preliminary data, actigraphy needs further study to determine if it can sufficiently measure the type of activity in the ICLJ setting. Future studies may correlate actigraphy data with chart or recorded activity data in an attempt to capture type of activity without using direct observation. Actigraphy did provide useful information about the duration and frequency of activity of critically ill patients, with acceptable correlations to direct observation. Because these methods are not interchangeable for investigating the type, intensity, frequency, and duration of activity in patients who are not mobile, a mixed methods approach is recommended for future studies in this population and setting.

CONCLUSION

Exploring the role of therapeutic activity in the ICU is rich with promise. Although bedrest is a common prescription in the ICU, we believe that therapeutic activity can be initiated to avoid the hazards of prolonged hospitalization and associated immobility. Results of this study provide information for investigators and practitioners who use and measure therapeutic activity in hospitalized and critically ill patients. First, logged observations were useful in documenting the specific type of activity, but are expensive and do not protect against observer error. Second, actigraphy demonstrated promise as an efficient method of indicating duration and frequency of activity in chronically critically ill patients, but it was not sufficiently precise to distinguish intensity of activity. Therefore, in order to understand activity in this patient population, we need additional refinements to logged observations and intensity of movement. We need to distinguish between actual and perceived barriers in the initiation of therapeutic activity. And finally, further investigation of the relationship between therapeutic activity and patient outcomes is recommended.

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Erratum

In the July/August 2005 issue of DCCN. the author, Ricarda M. White. MSN, RN, MSEd. was misidentified as "he" under "About the Author." Ms. White had written the article, "The Role of Brain Natriuretic in Systohc Heart Failure." The editor apologizes to Ms. White.

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Subject ___________ (code) Date __________ Staff RN__________

Record patient activity in real time. Indicate the level of agitation over the course of one hour at the end of the hour0 in the MAAS column using the scale BELOW as the MAAS score. Record the length of time spent in mobilization activities.

MAAS SCORE

Score	*Description*	*Definition*
0	*Unresponsive*	*Does not move with stimulus of suction OR 5 seconds of vigorous orbital, sternal, or nailbed pressure*
1	*Responsive only to noxious stimuli*	*Opens eyes OR raises eyebrows OR turns head toward stimulus OR moves limbs with noxious stimulus*
2	*Responsive to touch or name*	*Opens eyes or raises eyebrows OR turns head toward stimulus OR moves limbs when touched or name is loudly spoken*
3	*Calm and cooperative*	*No external stimulus is required to elicit movement AND patient is adjusting sheets or clothes purposefully and follows commands*
4	*Restless and cooperative*	*No external stimulus is required to elicit movement AND patient is picking at sheets or tubes OR uncovering self and follows commands*
5	*Agitated*	*No external stimulus is required to elicit movement AND attempting to sit up OR moves limbs out of bed AND does not consistently follow commands (e.g., will lie down when asked but soon reverts back to attempts to sit up or move limbs out of bed)*
6	*Dangerously agitated, uncooperative*	*No external stimulus is required to elicit movement AND patient is pulling at tubes or catheters OR thrashing side to side OR striking at staff OR trying to climb out of bed AND does not calm down when asked*

Clock Time	MAAS SCORE (above; scale 0–6)	Turning; repositioning lateral/ supine/ Prone. How long in total time?	ROM. How long in total time?	Dangle. How long in total time?	Sit in chair. How long in total time?	Ambulate. How long in total time?	Other activity? SPECIFY! How long in total time?	Initiated by whom?
11	3	L-to-back 15 seconds					Patient points to TV 10 seconds	RN
11:10	3						Restless hand movements R > L 45 seconds	Patient

Figure 1.

Abbreviated sample observation log. The MAAS has a range of scores from 0 to 6 with zero indicating no activity and 6 near constant movement and agitation. The MAAS was designed to measure patient activity in response to pharmacological sedation. Developed by an intensivist, it has content validity as assessed by bedside ICU nurses and a demonstrated correlation with other measures of agitation ($r = 0.5$, $P < .001$). Interrater reliability for the MAAS has been reported as a kappa of 0.83.[23] Although designed to evaluate the patient response to sedative agents, the MAAS does measure motor activity that is both patient-initiated and potentially not beneficial (ie, not therapeutic). The space to record logged observations included (a) time for the beginning and ending of activity, (b) the type of activity, and (c) a notation of who initiated the activity (subject, nurse, physical therapist, doctor, family, others). Observations were written in longhand. Blank space or no writing indicated an absence of activity.

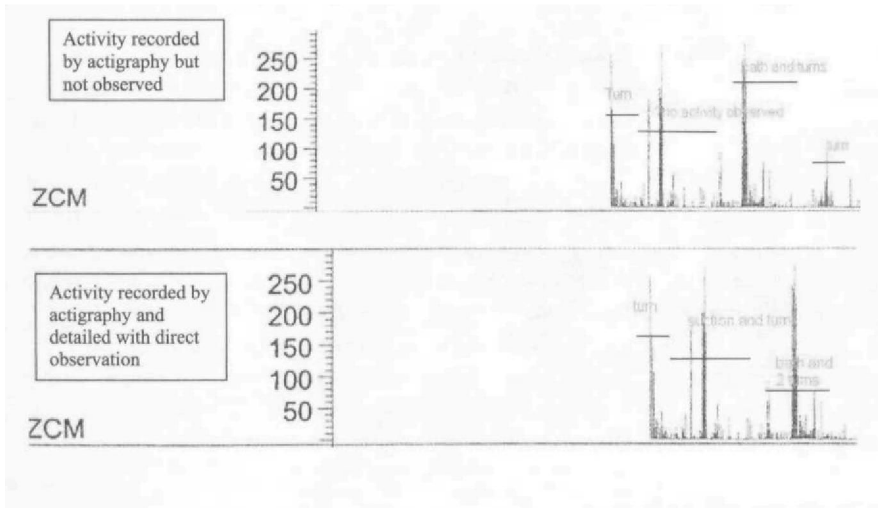

Figure 2.
Best and worst case scenarios comparing actigraph with direct observation. Note several spikes indicating activity in the first (top) graph when no activity was observed or recorded concurrently by the data collector. In the second (bottom) graph, the spikes correlate well with observations of therapeutic activity. Note also the small spikes indicating a wakeful state or active muscle tone in both actigraphs.

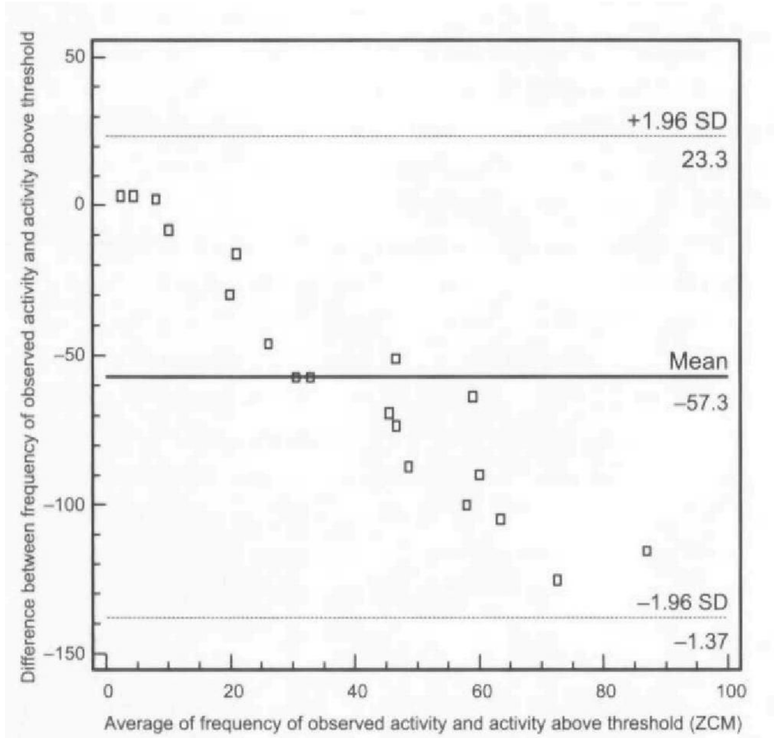

Figure 3.
Bland-Altman plot comparing averaged frequency of activity measured by actigraphy (zero crossing mode or ZCM values) with averaged frequency of logged observations.

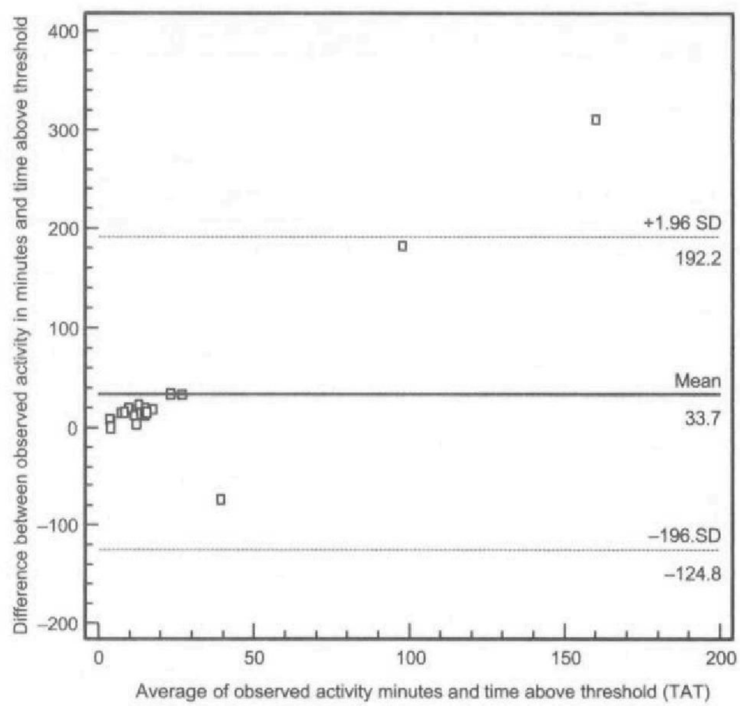

Figure 4.
Bland-Altman plot comparing averaged time in activity measured by actigraphy [time above threshold (TAT)] with logged observations.

TABLE 1

Demographic Characteristics of ICU Patients (N = 20)

	Characteristics	n (%)/score
Gender	Male	8 (40%)
	Female	12 (60%)
Age (mean, years ± SD)		59.8 ± 16.45
Race	White	12 (60%)
	African American	8 (40%)
Sedation status	Yes	3 (15%)
	No	17 (85%)
APACHE 111 score at admission to ICU (mean, score ± SD)		79.8 ± 24
Length of ICU stay (mean, days ± SD)		27 ± 23.4
Hospital length of stay (mean, days ± SO)		32 ± 25.9

ICU indicates intensive care unit.

TABLE 2

Summary of the Observation Log over 8 Hours (N = 20)

Therapeutic Activity	Total Time Observed (minutes)	Total Time Recorded by Actigraphy (minutes)	Frequency Observed (number of times observed)	Frequency Recorded by Actigraphy (number of activity spikes)
Total amount	788.5	1,280	196	251
Turning	193.5		113	
ROM	130		11	
Sitting in chair (n = 2)	464		2	
Dangle	0		0	
Ambulation	0		0	
Standing	1		1	

ROM indicates range of motion.