An Integrative Review of Subjective and Objective Measures of Sleep Disturbances in Breast Cancer Survivors

Pinky H. Budhrani, PhD, ARNP, Cecile A. Lengacher, PhD, RN, Kevin Kip, PhD, Cindy Tofthagen, PhD, ARNP, and Heather Jim, PhD

Background: Sleep disturbances are recognized as a side effect of cancer treatment, affecting physiological and psychological functioning. Sleep disturbances can persist through treatment and survivorship, and are increasingly prevalent among breast cancer survivors (BCSs).

Objectives: The purpose of this review is to summarize current research on subjective and objective measures of sleep disturbances, the association between subjective and objective measures, and interventions used to manage sleep disturbances among BCSs after the completion of treatment.

Methods: Articles published from 2003–2013 were retrieved using PubMed, Web of Science, and ScienceDirect. Key search terms included breast cancer, sleep actigraphy, and sleep disturbances. Articles assessing sleep subjectively and objectively in the post-treatment period were included.

Findings: Twelve studies met the inclusion criteria: seven descriptive studies; one interventional study; three randomized, controlled trials; and one longitudinal study. Nighttime awakenings and wake after sleep onset were the most affected sleep variables. Association between subjective and objective sleep was significant among metastatic BCSs. Cognitive-behavioral interventions showed significant improvements in sleep quality.

Advances in therapies have increased survival rates for patients with breast cancer; however, therapies are often associated with physical and psychological distress that have profound effects on quality of life (QOL) (Segrin & Badger, 2014). This distress is often presented as a cluster of symptoms that includes depression, pain, and sleep disturbances (Lengacher et al., 2012). Sleep disturbances are an increasingly recognized side effect of cancer treatment among breast cancer survivors (BCSs). The prevalence of sleep disturbances ranges from 20%–70% of BCSs, which is twice that found in the general population (Fiorentino, Rissling, Liu, & Ancoli-Israel, 2011). Contributing factors of sleep disturbances include vasomotor symptoms and comorbid-related conditions, such as fatigue, depression, and anxiety (Pinto & de Azambuja, 2011). Savard, Simard, Blanchet, Ivers, and Morin (2009) reported that 58% of BCSs who were about four years postdiagnosis reported sleep disturbances. In addition, BCSs who completed radiation therapy experienced sleep disturbances persisting for six months (Dhruva et al., 2012). Sleep disturbances persist through survivorship and are associated with increased comorbidities and early mortality among BCSs (Palesh et al., 2014).

Sleep disturbances can be measured subjectively and objectively. Subjective measures include the Pittsburgh Sleep Quality Index (PSQI) (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) and the General Sleep Disturbance Scale (GSDS) (Lee, 1992). Objective measures include polysomnography and actigraphy.
actigraphy (Dhruva et al., 2012). Actigraphy provides a noninvasive method of quantifying continuous body movements using a device resembling a wristwatch known as an actiwatch. The actiwatch uses internal motion sensors to capture movements, represented as the number of accelerations per minute (Grutsch et al., 2011). Specialized software is used to determine sleep versus wake parameters, including nocturnal awakenings, sleep efficiency (SE), sleep onset latency (SOL), total sleep time (TST), and wake after sleep onset (WASO) (see Table 1).

The use of interventions has increased among BCSs because of their potential to improve physical and psychological functioning (Zeng, Huang, Cheng, Zhou, & So, 2014). Behavioral interventions have positive outcomes on sleep disturbances without the effects of medication (Pinto & de Azambuja, 2011). Current guidelines recommend using interventions in conjunction with medications for the management of sleep disturbances, and research evaluating the use of interventions among BCSs is essential (Berger, Farr, Kuhn, Fischer, & Agrawal, 2007).

Previous research has indicated that subjective measures do not always correlate with objective measures (Lauderdale, Knutson, Yan, Liu, & Rathouz, 2008; Miaskowski et al., 2011). Both types of assessment are recommended to accurately measure the prevalence of sleep disturbances among BCSs (Berger et al., 2005; Epstein & Dirksen, 2007). In addition, with the increasing number of BCSs, assessing for sleep disturbances post-treatment is imperative. Prior reviews have evaluated sleep disturbances among patients receiving chemotherapy, but limited research has been completed on sleep disturbances and the use of interventions in the post-treatment period (Kotronoulas, Wengström, & Kearney, 2012; Palesh et al., 2012). Therefore, the purpose of this review was to summarize current research on subjective and objective measures of sleep disturbances, the association between subjective and objective measures, and interventions used to manage sleep disturbances among BCSs after the completion of treatment.

### Methods

A search of three databases (i.e., PubMed, Web of Science, and ScienceDirect) was completed. Search terms included the following: (a) breast cancer AND sleep actigraphy, (b) breast cancer AND sleep quality AND objective sleep, (c) breast cancer AND sleep disturbance, (d) breast cancer AND sleep disturbance AND sleep actigraphy, and (e) breast cancer AND sleep actigraphy AND sleep quality.

Articles were evaluated using the following inclusion criteria: (a) written in the English language, (b) quantitative studies, (c) published within the past 10 years (2003–2013), (d) participants included women (older than age 18 years) diagnosed with breast cancer who have completed treatment (i.e., surgery, radiation therapy, or chemotherapy), (e) examined objective sleep using actigraphy, (f) examined subjective sleep using self-report questionnaires, and (g) published in peer-reviewed journals. Exclusion criteria included the following: (a) qualitative studies, (b) meta-analyses, (c) case studies, (d) unpublished studies, (e) abstract-only articles, and (f) dissertations. Review articles were included in the narrative. The first author verified study selection, data extraction, and screening using the inclusion and exclusion criteria.

A total of 269 articles were identified: 176 were from ScienceDirect, 61 were from Web of Science, and 32 were from PubMed. Abstracts of these potential articles were screened using the inclusion and exclusion criteria. Only articles using actigraphy and self-report questionnaires were extracted. Twelve articles were eligible, and study findings were analyzed and presented in Table 2.

### Results

#### Study Designs

Results included seven descriptive studies; three randomized, controlled trials (RCTs); one interventional study; and one longitudinal study. The RCTs and interventional studies included a yoga intervention, acupuncture, home-based walking intervention, and cognitive-behavioral intervention (CBI) for treating insomnia in BCSs (Epstein & Dirksen, 2007; Mustian et al., 2013; Otte, Carpenter, Zhong, & Johnstone, 2011; Payne, Held, Thorpe, & Shaw, 2008).

#### Sample Characteristics of Selected Studies

Sample sizes ranged from as low as 10 to as high as 308 BCSs. The mean age of the participants ranged from 51–65 years. Studies included BCSs who had completed their last cycle of chemotherapy to 6.75 years after treatment (Otte, Carpenter, et al., 2011). One study included only stage IV BCSs (Palesh et al., 2008). The remaining studies were heterogeneous in terms of stage of breast cancer and type of treatment.

#### Subjective Sleep Assessment

The PSQI was one of the main instruments used to measure sleep (Buysse et al., 1989). The instrument consists of 19 questions referring to participants’ sleep quality, SOL, sleep duration, SE, sleep disturbances, sleep medications, and daytime dysfunction during the past month (Carpenter

### TABLE 1. Descriptive Statistics of Actigraphy Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
<th>Average Population Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nocturnal awakenings</td>
<td>Number of awakenings during the sleep period</td>
<td>2–6 awakenings</td>
</tr>
<tr>
<td>Sleep efficiency</td>
<td>Number of minutes of sleep divided by the number of minutes in bed, multiplied by 100</td>
<td>Greater than 85%</td>
</tr>
<tr>
<td>Sleep-onset latency</td>
<td>Number of minutes between laying in bed and falling asleep</td>
<td>Less than 20 minutes</td>
</tr>
<tr>
<td>Total sleep time</td>
<td>Number of minutes of sleep while in bed</td>
<td>420–540 minutes</td>
</tr>
<tr>
<td>Wake after sleep onset</td>
<td>Number of minutes awake after sleep onset during the sleep period</td>
<td>Less than 42 minutes</td>
</tr>
</tbody>
</table>

Note. Based on information from the American Academy of Sleep Medicine, 2005.
TABLE 2. Summary of the Included Studies With Subjective Sleep and Sleep Actigraphy Among BCSs

<table>
<thead>
<tr>
<th>Study</th>
<th>Purpose</th>
<th>Sample</th>
<th>Sleep Measures</th>
<th>Findings</th>
</tr>
</thead>
</table>
| Berger et al., 2003 | A descriptive study to evaluate outcomes of an intervention designed to promote sleep after adjuvant breast cancer chemotherapy | 73 BCSs with a mean age of 55.3 years who completed four cycles of doxorubicin chemotherapy | • Daily diary  
• Pittsburgh Sleep Quality Index  
• Wrist actigraphy | WASO exceeded 30 minutes per night; sleep efficiency scores ranged from 82%–92%; TST ranged from 7–8 hours per night; nighttime awakenings ranged from 10–11 per night. The intervention positively improved all sleep measures except nighttime awakenings. |
| Berger et al., 2012 | A descriptive study to examine the relationships between six circadian parameters, symptoms, and physical functioning | 156 BCSs with a mean age of 51.8 years who were at least one year post-treatment | • Pittsburgh Sleep Quality Index  
• Wrist actigraphy | As BMI increased, weaker circadian rhythms were recorded. One year after the first chemotherapy treatment in participants with a BMI of 30 kg/m², significant correlations were observed between circadian parameters, anxiety, fatigue, and physical functioning. |
| Dhruba et al., 2012 | A longitudinal study to examine how actigraphy and self-report ratings of sleep disturbance changed during and after RT | 73 BCSs with a mean age of 55.1 years who completed RT | • General Sleep Disturbance Scale  
• Wrist actigraphy | Greater than 85% of the sample had an abnormally high number of nighttime awakenings of 15 per night. About 46% of the sample had WASO of 11%. Subjective sleep disturbance was influenced by other subjective symptoms (e.g., depression, fatigue), but only BMI predicted variability in WASO. |
| Enderlin et al., 2011 | A descriptive study to examine subjective sleep quality and describe objective sleep characteristics and insomnia symptom severity | 67 BCSs (32 women with and 35 without non-metastatic breast cancer) with a mean age of 65.08 years | • Pittsburgh Sleep Quality Index  
• Wrist actigraphy  
• Insomnia Severity Index  
• Epworth Sleepiness Scale | Depressed mood predicted poor subjective sleep quality. Nocturnal awakenings and mean sleep onset latency were higher for the breast cancer group (9.2 versus 7.3 minutes and 34.8 versus 15.6 minutes, respectively). Mean insomnia severity scores indicated insomnia symptoms for the breast cancer group compared to the control group (8.9 versus 6.4). |
| Epstein & Dirksen, 2007 | An RCT to determine the efficacy of a cognitive-behavioral intervention for treating insomnia in BCSs | 72 BCSs with a mean age of 59.1 years who were at least three months post-primary treatment | • Daily sleep diaries  
• Wrist actigraphy | Significant time effects were found for sleep onset latency, WASO, TST, time in bed, sleep efficiency, and sleep quality, indicating improvement after the intervention. After treatment, the multicomponent intervention group spent significantly less time in bed than the control group. |
| Minton & Stone, 2012 | A descriptive study to examine differences in objective cognitive function, activity levels, and sleep in disease-free women who do and do not meet criteria for CRFS | 114 BCSs (69 controls and 45 patients with CRFS), with a mean age of 57.3 years | • Insomnia Severity Index  
• Wrist actigraphy | Significant differences were seen between groups on fatigue, mood, sleep, quality-of-life scores, and in objective cognitive testing. Actigraphy indicated an overall difference between groups in daytime activity, but not in TST or sleep quantity. Subjective sleep disturbance did not correlate with objective measures. |
| Mustian et al., 2013 | An RCT to determine the efficacy of a standardized yoga intervention compared with standard care for improving global sleep quality | 308 BCSs with a mean age of 54 years who were 2–24 months post-treatment | • Pittsburgh Sleep Quality Index  
• Wrist actigraphy | Yoga participants demonstrated greater improvements in sleep onset latency, sleep duration, daytime dysfunction, and medication use postintervention compared to standard care participants. |
| Otte, Carpenter, et al., 2011 | An interventional study to describe patterns of acupuncture use and evaluate patterns of symptom change over time | 10 BCSs with a mean age of 53 years who were, on average, 6.75 years postdiagnosis | • Pittsburgh Sleep Quality Index  
• Wrist actigraphy  
• Sleep diary | Sleep onset latency increased after treatment from week 5 to 8, WASO decreased from baseline to week 8, and the number of hot flashes decreased from baseline to week 5. |
| Otte, Payne, et al., 2011 | A descriptive study to determine the minimum number of nights needed to obtain an accurate picture of objective sleep | 55 BCSs with a mean age of 54 years who had completed primary cancer treatment | • Sleep diary  
• Wrist actigraphy | TST was less than 360 minutes. The average sleep efficiency was 78%, mean sleep latency was 67 minutes, and mean number of sleep disturbances was 24.1. Sleep onset latency showed the greatest variation during seven nights of actigraphy collection. |

BCS—breast cancer survivor; BMI—body mass index; CRFS—cancer-related fatigue syndrome; RCT—randomized, controlled trial; RT—radiation therapy; TST—total sleep time; WASO—wake after sleep onset.

(Continued on the next page)
TABLE 2. Summary of the Included Studies With Subjective Sleep and Sleep Actigraphy Among BCSs (Continued)

<table>
<thead>
<tr>
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<th>Purpose</th>
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<th>Sleep Measures</th>
<th>Findings</th>
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</thead>
<tbody>
<tr>
<td>Palesh et al., 2008</td>
<td>A descriptive study to determine the relationship between hypothalamic pituitary axis dysregulation, vaginal functioning, and sleep problems in BCSs</td>
<td>99 stage IV BCSs with a mean age of 54.6 years</td>
<td>• Sleep questionnaire  • Wrist actigraphy</td>
<td>Participants spent an average of 478.5 minutes in bed, taking an average of 11.5 minutes to fall asleep, and had a mean WASO of 71.44 minutes, giving a sleep efficiency of 85% (SD = 11%). Participants had 15 (SD = 6.6) wake episodes each night.</td>
</tr>
<tr>
<td>Payne et al., 2008</td>
<td>An RCT to compare the effectiveness of a prescribed home-based walking exercise intervention in BCSs receiving hormone treatment</td>
<td>20 BCs with a mean age of 64.7 years who were receiving hormone therapy with tamoxifen, anastrozole, or letrozole</td>
<td>• Pittsburgh Sleep Quality Index  • Wrist actigraphy</td>
<td>Exercise group scores on the Pittsburgh Sleep Quality Index decreased significantly over time but not within the control group. Shorter wake time and less movement were noted in the exercise group.</td>
</tr>
<tr>
<td>Rissling et al., 2011</td>
<td>A descriptive study to examine the relationship between menopausal symptoms, sleep quality, and mood in BCSs</td>
<td>69 BCs with a mean age of 48.4 years who completed four cycles of anthracycline-based chemotherapy</td>
<td>• Pittsburgh Sleep Quality Index  • Wrist actigraphy</td>
<td>Premenopausal participants experienced a significant decrease in TST and an increase in nighttime awakenings from 21 to 29 after the completion of chemotherapy. Postmenopausal participants did not experience changes in TST and nighttime awakenings after the completion of chemotherapy.</td>
</tr>
</tbody>
</table>

BCS—breast cancer survivor; BMI—body mass index; CRFS—cancer-related fatigue syndrome; RCT—randomized, controlled trial; RT—radiation therapy; TST—total sleep time; WASO—wake after sleep onset

& Andrykowski, 1998). Additional sleep instruments include the GSND, Insomnia Severity Index (ISI), and Epworth Sleepiness Scale (ESS). The GSND (Lee, 1992) consists of 21 questions assessing participants’ sleep quality, sleep quantity, SOL, mid-sleep awakenings, early awakenings, sleep medications, and daytime sleepiness during the past week. The ISI (Morin, Belleville, Belanger, & Ivers, 2011) consists of six questions evaluating SOL, sleep maintenance, morning awakenings, sleep dissatisfaction, daytime functioning, noticeability of sleep problems by others, and sleep distress during the past month. The ESS (Johns, 1991) consists of eight questions assessing daytime sleepiness. Some studies used the daily sleep diary as a reliable, self-report sleep measure (Epstein & Dirksen, 2007; Otte, Payne, & Carpenter, 2011).

Objective Sleep Assessment Among Non-Metastatic Breast Cancer Survivors

All 12 studies included sleep actigraphy as an objective measure of sleep disturbances. These studies examined the following actigraphy variables: SE, TST, SOL, nocturnal awakenings, and WASO.

Sleep efficiency:SE is defined as the percentage of time in bed sleeping (American Academy of Sleep Medicine, 2005) and is calculated by dividing the number of minutes of sleep by the number of minutes in bed, multiplied by 100. In adults, 85% SE is indicative of a good night’s sleep (American Academy of Sleep Medicine, 2005). Studies indicated that SE was not significantly affected in BCSs (Dhruva et al., 2012; Enderlin et al., 2011). SE was about 82%-92% in BCSs after chemotherapy (Berger et al., 2003). In addition, mean SE was also greater than 85% for BCSs four months after radiation therapy (Dhruva et al., 2012). Mean SE was the lowest in one study that measured actigraphy during seven nights, suggesting that increased duration of actigraphy recording may produce different results (Otte, Payne, et al., 2011).

Total sleep time:Adults usually sleep from 420–540 minutes per night (American Academy of Sleep Medicine, 2005). TST ranged from 386–480 minutes after chemotherapy compared to 420 minutes after radiation therapy among BCSs (Berger et al., 2003). These studies measured actigraphy during 48 hours. During seven nights of actigraphy measurement, TST was less than 360 minutes per night and was consistently low throughout the week (Otte, Payne, et al., 2011).

Sleep onset latency:SOL is the duration of time from bedtime to falling asleep (American Academy of Sleep Medicine, 2005). SOL is usually less than 20 minutes (American Academy of Sleep Medicine, 2005). Mean SOL was about 15 minutes after radiation therapy (Dhruva et al., 2012). After chemotherapy, mean SOL was 15.6 minutes compared to 15.6 minutes for the non-cancer control group (Enderlin et al., 2011). During seven nights of actigraphy measurement, mean SOL was 67 minutes and showed the greatest variation of all actigraphy parameters (Otte, Payne, et al., 2011).

Nocturnal awakenings:Adults usually awaken 2–6 times per night (American Academy of Sleep Medicine, 2005). Three nights of actigraphy data indicated an average of 10 awakenings per night (Berger et al., 2003). The number of awakenings increased from 21 to 29 awakenings after chemotherapy in BCSs with regular menstrual cycles (Rissling, Liu, Natarajan, He, & Ancoli-Israel, 2011). However, postmenopausal BCSs and BCSs with irregular menstrual cycles experienced no significant change in the number of awakenings from pre- to postchemotherapy. In addition, 87% of BCSs had an increased number of nocturnal awakenings, with an average of 15 per night after radiation therapy (Dhruva et al., 2012).

Wake after sleep onset:In adults sleeping 420 minutes per night, WASO is usually less than 42 minutes (American Academy of Sleep Medicine, 2005). In addition, mean WASO was greater than 85% for BCSs after chemotherapy (Berger et al., 2003). The number of awakenings ranged from 386–480 minutes after chemotherapy compared to 386 minutes after radiation therapy among BCSs (Berger et al., 2003). These studies measured actigraphy during 48 hours. During seven nights of actigraphy measurement, WASO was less than 360 minutes per night and was consistently low throughout the week (Otte, Payne, et al., 2011).

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Sleep disturbances and the effects of interventions varied among BCs. Radiation therapy, chemotherapy, and hormone therapy were positively associated with increased nocturnal awakenings in BCs (Palesh et al., 2008; Dhruva et al., 2012). WASO was significantly increased in metastatic BCs and positively associated with tamoxifen therapy. Nocturnal awakenings were the most affected actigraphy parameter, and WASO showed large variability in the studies. SOL and SE were the least affected variables; most studies indicated mean SOL of less than the 20 minutes per night and mean SE of greater than 85%. Acupuncture improved WASO, sleep hygiene practices had a positive effect on SOL and TST, and behavioral therapy showed long-term improvement for BCs after the completion of chemotherapy.

Discussion

This review is the first to explore subjective and objective measures of sleep disturbances in BCs after the completion of treatment. The findings indicated that sleep quality remained poor after treatment among BCs. One year after the completion of chemotherapy, actigraphy parameters were not significantly different from findings one month after the completion of chemotherapy, suggesting limited improvement in sleep and that chemotherapy had a sustained negative effect on sleep quality.

In addition, the association between subjective and objective sleep measures was small. This finding is consistent with previous research that reported a lack of correspondence between subjective and objective sleep in older women (Vitiello, Larsen, & Moe, 2004). One of the challenges of actigraphy is that it identifies inactivity in movement as sleep and wrist activity as wakefulness, leading to an underestimation of SOL and overestimation of TST (Pollak, Tryon, Nagaraja, & Dzwonczyk, 2001; Vallieres & Morin, 2003). SOL is a continuous rather than a discrete process, as measured by actigraphy (Tryon, 2004).
Clinically, it is important to inquire about TST or SOL by asking patients, “How many hours are you sleeping at night?” or, “How long does it take you to fall asleep?” This information can then be used to verify objectively measured TST and SOL.

This review highlighted limitations in the selected studies that may have affected the results. Time since completion of treatment varied from the completion of the last cycle of chemotherapy to 6.75 years after adjuvant therapy. The period of actigraphy varied among studies from 48–168 hours. In addition, chemotherapy protocols and duration of treatment varied among patients. Women with more aggressive chemotherapy may have worse sleep patterns (Kotronoulas et al., 2012). In addition, several studies did not evaluate women’s past history of poor sleep or use of sleep medications. BCSs in these studies were primarily Caucasian. Future research on ethnically diverse populations is needed.

Implications for Nursing

The subjective and objective assessment of sleep disturbances as part of survivorship care for BCSs is ideal; however, objective assessments may not be feasible in practice. Baseline assessment of sleep disturbances is the initial step and should include documentation of predisposing factors, sleep patterns, emotional status, activity levels, exercise, diet, symptoms, and medications of BCSs before the start of treatment (American Academy of Sleep Medicine, 2005). In addition, the National Comprehensive Cancer Network (2015) guidelines for sleep disorders recommend screening cancer survivors at regular intervals with the following questions, “Do you have difficulty falling or staying asleep?” “How long does it take to fall asleep?” or, “How many times do you wake up every night?” Special consideration should be placed on BCSs with complaints before the start of treatment to initiate practices to prevent further worsening of sleep.

Nurses are in a unique position to educate, develop, and integrate evidence-based practice into the management of sleep disturbances early in the course of cancer treatment. Oncology nurses must collaboratively work with BCSs to incorporate sleep hygiene practices and generate shared goals. For example, patients with increased nocturnal awakenings can be informed about online CBI programs. CBI is the only intervention that is approved by the Oncology Nursing Society’s (2015) Putting Evidence Into Practice resource as likely to be effective for the management of sleep disturbances among patients with cancer. Several resources provide comprehensive information about sleep disorders, self-administered assessments, online forums, sleep hygiene tips, and professional assistance (see Figure 1).

Nurses contribute to the coordination of patient care and interpersonal relationships among healthcare providers (Yagasaki & Komatsu, 2013). By referring BCSs to appropriate follow-up care, nurses may also assist in the identification of other symptoms associated with sleep, including pain, fatigue, and depression, that often present as symptom clusters among BCSs (Lengacher et al., 2012). Recognition of barriers, such as finances, residential and social status, and access, is important for successful follow-up care (Hale & Do, 2007). Early assessment and follow-up care for sleep disturbances are vital to decrease symptom distress and improve QOL among cancer survivors.

This review has several implications for future research. The effect of different types of chemotherapies on actigraphy parameters should be further elucidated. Increased nocturnal awakenings were positively predicted by chemotherapy and radiation therapy. The replication of this finding in additional studies is warranted. The association between menopausal status, chemotherapy, and nocturnal awakenings is important.
to further analyze. One study indicated that SE was within the normal range for BCSs except 90 days after the completion of chemotherapy (Berger, Hertzig, Geary, Fischer, & Farr, 2012). This finding should be further explored.

The period of actigraphy measurement should be increased to seven nights in future studies. Seven nights of actigraphy collection indicated shortened TST and prolonged WASO and SOL in BCSs, compared to studies measuring actigraphy for two nights (Otte, Payne, et al., 2011). Finally, additional research is needed on the cancer-specific physiological, psychological, and behavioral factors that contribute to the development of sleep disturbances, particularly increased nocturnal awakenings and WASO among metastatic BCSs.

**Conclusion**

Sleep disturbances are prevalent and often not reported by BCSs. The findings of this review indicated the importance of assessing sleep from baseline throughout the cancer trajectory. Nocturnal awakenings and WASO were the most affected actigraphy parameters in BCSs and were significantly predicted by type of treatment. Several interventions exist for the management of sleep disturbances. Behavioral interventions showed positive and long-term effects of improved sleep quality among BCSs and should be integrated into survivorship care plans.

**References**


Minton, O., & Stone, P.C. (2012). A comparison of cognitive function, sleep and activity levels in disease-free breast cancer patients with or without cancer-related fatigue syndrome. *BMJ Supportive and Palliative Care*, 2, 231–238


