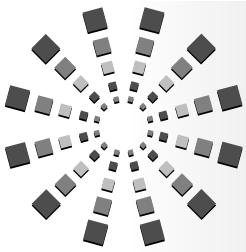

Julie L. Otte, PhD, RN
Janet S. Carpenter, PhD, RN

Theories, Models, and Frameworks Related to Sleep-Wake Disturbances in the Context of Cancer

KEY WORDS
Cancer
Framework
Model
Sleep-wake disturbances
Theory

The purpose of this article was to review theories, models, and frameworks of sleep disturbances referenced in the cancer literature. Sleep-wake disturbances in cancer are a significant problem that negatively affects quality of life. There is no previously published review of the theories, models, or frameworks used to study sleep-wake disturbances in the context of cancer. Describing existing theories or models and their application in cancer is important to advance knowledge in this area. Two theories and 9 models were identified for review. These have been used to further understand the problem of sleep-wake disturbances as a primary or secondary symptom within the cancer literature. Searches were conducted from January 1, 1970, to July 31, 2008, to find relevant articles using 4 electronic databases: MEDLINE, CINAHL, PubMed, and PsychINFO. On the basis of the search, 73 descriptive or intervention studies were identified and reviewed. Most research was atheoretical, with no identified theory, model, or framework. In studies that did use theory or models, few were applied in more than one study. Although several commonalities across models did emerge, a more comprehensive and widely used model could help guide nursing research to facilitate effective symptom management for this prominent problem in cancer.

Sleep-wake disturbances in the context of cancer are increasingly being recognized as a significant problem.[1–3] Sleep has been characterized as a psychobiological event that includes physiological, psychological, and behavioral mechanisms.[4] Sleep-wake disturbances have been defined as disruptions in nighttime sleep or wakefulness that can result in negative health outcomes.[4] In various American and Canadian samples, 18% to 90% of cancer patients and survivors

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Corresponding author: Julie L. Otte, PhD, RN, 1111 Middle Dr, Indianapolis, IN 46202-5107 (jlelam@iupui.edu).
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reported subjective sleep-wake disturbances.[2,3,5–9] Subjectively reported sleep-wake disturbances can include a variety of diagnosable sleep-wake problems such as insomnia, restless leg syndrome, periodic limb movement disorder, obstructive sleep apnea, or daytime sleepiness. Of these, insomnia (difficulty falling asleep, staying asleep, or early awakening) is commonly reported among cancer patients and survivors.[10] Sleep-wake disturbances are important to address because, if left untreated, they can negatively effect quality of life.[9,11–13]

A number of descriptive and intervention studies have targeted sleep-wake disturbances in various cancer populations,[2,14,15] and there are extensive published reviews of the physiology, measurement, and terminology of sleep-wake disturbances in cancer.[10,16–19] One common limitation noted within this literature has been the lack of conceptual clarity, in-part due to the inconsistent use or lack of disclosure of guiding theories, models, or frameworks.[17,19] To the best of our knowledge, a review article describing the theory, models, or frameworks used to guide research in this area has not been previously published.

The purpose of this article was to review theories, models, or frameworks applied to the problem of sleep-wake disturbances in the context of cancer. The main goals of this review were to (1) quantify, summarize, and compare the number of studies with and without explicitly described theories, models, or frameworks and (2) summarize and compare the theories, models, and frameworks that were used.

This review was important because theoretically grounded research advances science for evidence-based nursing research. One could question whether it is more important to base research on a theory, model, or framework or to have clear and consistent variable names, definitions, and measurement of sleep. We argue the former. Theories, models, or frameworks are important because they provide direction for research designs, assessment tools, and intervention development for effective symptom management. Typically, authors list the theories, models, or frameworks that specify interrelationships of critical attributes of concepts related to a problem. These critical attributes then link research findings to a body of knowledge that can be used by healthcare professionals for symptom management.[20] Therefore, it is through the use of the underlying theories, models, and frameworks that we better understand the definitions and measurement of certain research phenomena.

In nursing, the terms *theory*, *model*, and *framework* are often used interchangeably. By definition, a theory provides systematic explanations about relationships among phenomena, whereas a concept is based on observed characteristics or behaviors such as sleep.[20] A theory generally includes relational statements that are useful for explanation, description, prediction, control, or prescription based on definitions of the underlying concepts.[21] A model is a symbolic representation of relationships among variables or concepts.[20] A framework is often the illustration that describes the conceptual underpinnings of the research and can be based on a theory or, more specifically, on a concept (such as sleep-wake disturbances).[20,21]

■ Methods

Data Sources

Searches were conducted to find relevant articles. Using MEDLINE, CINAHL, PubMed, and PsychINFO search engines (n = 4), citations from January 1, 1970, to July 31, 2008, were reviewed. Search terms used alone and in combination included the following: *sleep*, *wake*, *disturbance*, *impaired sleep*, *insomnia*, *theoretical*, *conceptual*, *model*, *framework*, *adult*, *cancer*, and *survivor*. We identified articles that included cancer patients undergoing treatment and cancer survivors (had completed treatment). Because these search terms resulted in more than 500 possible publications, articles were excluded from the review if they (1) were drug interventions, (2) focused on pediatric cancer or caregivers of cancer patients, (3) were instrument or questionnaire validation studies, (4) focused on statistical modeling of sleep-wake disturbances, (5) were letters to the editor or single case reports, or (6) reported sleep and wake as an incidental finding.

Procedures

On the basis of the above, 73 studies were identified and reviewed. We quantified the number of studies with and without an explicitly stated a theory, model, or framework to clearly define these subsets of the studies and avoid assumptions of vague descriptions of theoretical underpinnings. We then summarized studies based on these criteria: (1) discipline of authors; (2) type of study; (3) sample information including (*a*) cancer diagnosis, (*b*) cancer stage, and (*c*) treatment status; (4) study variables; and (5) measures of sleep-wake. We then used χ^2 tests to compare these criteria between studies with and without a theory, model, or framework.

Next, we evaluated whether sleep was a primary or secondary variable within each theory, model, or framework. We developed a written summary of each theory, model, or framework and identified and compared their key attributes.

■ Results

Quantification, Summary, and Comparison of Studies With and Without Explicitly Described Theories, Models, or Frameworks

Of the 73 studies, 51 (70%) did not contain a reported theory, model, or framework.[3,5,7,9,11,14,22–66] These studies were considered atheoretical because there was no explicit description of a theory, model, or framework that had guided the study. These 51 studies are listed alphabetically in Table 1. The remaining 22 (30%) articles included a description of a theory, model, or framework that guided the study.[1,2,6,12,15,67–82] These 22 studies are listed alphabetically in Table 2. Tables 1 and 2 provide a general summary of all studies based on our review criteria.

Comparisons between the 51 atheoretical and 22 theoretically based studies are provided in Table 3. χ^2 Tests of differences indicated that studies that included a theory, model, or framework were significantly (1) more likely to include authors from the discipline of nursing and (2) less likely to have included wrist actigraphy as an outcome measure.

Summary and Comparison of Theories, Models, and Frameworks

Table 4 contains a summary and comparison of theories, models, and frameworks. There were 2 nursing theories[83,84] and 9 different conceptual models.[67,71,72,85–93] Three conceptual models focused on sleep-wake disturbances as a primary variable of interest. Two theories and 6 additional models included sleep-wake disturbances as one of several variables. These 8 latter theories/models tended to include sleep-wake disturbances as a secondary variable or as one variable within a cluster of several symptoms (eg, pain, fatigue, and sleep-wake disturbances). A description of each theory and model follows, starting with ones that included sleep wake disturbances as a primary variable and concluding with those that included it as a secondary variable.

Models With Sleep-Wake Disturbances as a Primary Variable

BIOBEHAVIORAL MODEL OF ALTERED DYSREGULATION IN CIRCADIAN SYSTEMS

The Biobehavioral Model of Altered Dysregulation in Circadian Systems proposes mechanisms that contribute to sleep-wake disturbances manifested as circadian dysregulation.[71] The model postulates that psychological functioning (stress, depression, mood states) have direct-reciprocal relationships with the endocrine system, autonomic nervous system, and sleep system. Dysregulation can be attributed to one or more of these biological systems. Dysregulation can be measured by sleep duration and sleep quality, as well as by cortisol, melatonin, and autonomic nervous system activity. The ultimate outcome of this dysregulation is poor quality of life, impaired well-being, poor treatment adherence, fatigue, disease progression, and poorer survival.[71] This model was included in one article.[71]

SPIELMAN'S THREE-FACTOR INSOMNIA MODEL

Spielman's Three-Factor Insomnia Model proposes interactions among predisposing, precipitating, and perpetuating factors of insomnia.[94] This cognitive-behavioral model is also known as the 3P model. The model includes both stress and behavioral factors to explain the evolution of insomnia and describe how individual differences cause initiation of acute disturbances in sleep that become chronic. The model proposes that people with insomnia have predisposing factors or traits that, when combined with life stress (precipitating factors), lead to chronic insomnia if there are maladaptive coping strategies (perpetuating factors).[86] When a person with predisposing factors of insomnia experiences one or more precipitating factors, the result can be acute episodes of insomnia.[94] Perpetuating factors are behaviors used to compensate for the loss of sleep. This model was included in 2 articles.[67,73]

TWO-PROCESS MODEL OF SLEEP REGULATION

The Two-Process Model of Sleep Regulation provides an understanding of the physiological mechanisms that drive sleep and wakefulness.[88] The model has changed over time, as researchers were able to pinpoint mechanisms or processes of sleep in relation to the 2 major sleep cycles of non–rapid eye movement and rapid eye movement sleep. Visually, the model is a wavelike structure that shows the relationship between 2 physiological processes of sleep regulation, process S and process C. The homeostatic process (process S) increases during the awake state (drives the need for sleep) and decreases during sleep (decreases the need for sleep). Process S is considered the basic mechanism of sleep regulation. If there is a deficit of sleep, process S elicits a compensatory increase in the duration and intensity of sleep. This produces a sleepy feeling during wakefulness, thus driving the need or desire to correct this deficit by falling asleep. The circadian process (process C) determines alterations of high and low sleep propensity that are independent of prior sleeping-waking (the timing to sleep and wakefulness), which determines the onset and end of sleep.[88] Process C is directed by a clocklike mechanism that is not related to prior levels of sleep or the wake-like process S. Process C is the mechanism that helps the body stay asleep. It is driven by a pacemaker found in the brain called the hypothalamic suprachiasmatic nuclei, which works in conjunction with neurotransmitters that facilitate sleep and thermoregulatory processes. The interaction of process S and process C has been used to predict the timing and duration of sleep, structure of sleep, and changes in daytime wakefulness.[88] This model was adapted for use in one article.[1]

Theories or Models With Sleep Disturbances as a Secondary or Clustered Variable

MODEL OF QUALITY OF LIFE

The Model of Quality of Life identifies 4 domains that define an individual's quality of life. Developed within the discipline of nursing, the model has been used to describe the quality of life in cancer patients. The 4 domains include physical well-being (eg, sleep), psychological well-being (eg, depression), social well-being (eg, family distress), and spiritual well-being (hopefulness).[90–92,95,96] Each domain is stated to act singly or in combination with the other domains and ultimately impact quality of life. The specific symptoms or factors within each quality of life domain have been further studied in various cancers such as breast cancer (see the study of Ferrell et al[90]). For this model, sleep is depicted as a physical domain that could be singly or combined with other domain factors that impact quality of life.[90] This model was included in one article.[12]

Table 1 • Summary of Studies Without a Theory, Model, or Framework

Source	Disciplines of Authors	Type of Study	Sample	Stage of Cancer	Cancer tx Status	Variables of Interest	Measure of Sleep-Wake
Ancoli-Israel et al[22]	Psychiatry, medicine	Descriptive	Breast cancer	I–IIIa	Pre-tx	Fatigue, sleep quality, circadian rhythm functional status, depression	Pittsburgh Sleep Quality Index, wrist actigraph
Anderson et al[23]	Psychology, psychiatry, medicine, public health	Descriptive	Mixed sample of cancer	I–IV	NR	Fatigue, sleep disturbance, depression, mood	Sleep Disturbance Scale
Andrykowski et al[24]	Psychology, nursing, medicine	Descriptive	Bone marrow transplant	NR	Post–bone marrow transplantation	Fatigue, sleep quality, mood, depression	Pittsburgh Sleep Quality Index
Bardwell et al[25]	Psychiatry, psychology, medicine	Descriptive	Breast cancer	I–IIIa	Active or post-tx	Insomnia, depression, mood, functional status, physical health, health behaviors	Women's Health Initiative Sleep Disturbance Scale
Berger and Farr[54]	Nursing	Descriptive	Breast cancer	I–II	Active tx	Fatigue, daytime activity nighttime rest, circadian rhythms	Wrist actigraph
Bower et al[55]	Psychiatry, behavioral medicine, medicine, psychology, and biostatistics	Descriptive	Breast cancer	0–II	Post-tx	Fatigue, contributing factors of fatigue, depression, pain, menopausal factors, sleep, quality of life	Medical Outcomes Study-Sleep Scale
Broeckel et al[26]	Psychology and medicine	Descriptive	Breast cancer	I–III	Post-tx	Fatigue, sleep, mood, menopausal symptoms, depression/adjustment disorder	Pittsburgh Sleep Quality Index
Bruera et al[56]	Medicine	Descriptive	Mixed sample of cancer	Advanced disease	NR	Insomnia, hypnotic withdrawal, cognitive failure	Visual analog scale of insomnia items
Cannici et al[58]	Psychology, psychiatry	Intervention	Mixed sample of cancer	NR	Active and post-tx	Insomnia, muscle relaxation	Daily sleep questionnaire (sleep behaviors)
Chen et al[57]	Nursing, medicine	Descriptive	Lung cancer	III–IV	Active tx	Sleep disturbances, chemotherapy, quality of life, functional performance	Pittsburgh Sleep Quality Index
Cohen et al[27]	Psychology, public health, medicine, biostatistics, religion	Intervention	Lymphoma	I–IV	Active or post-tx	Sleep quality, psychological adjustment, depression, anxiety, impact of life event, fatigue	Pittsburgh Sleep Quality Index
Coleman et al[59]	Nursing, biostatistics, public health, education	Intervention	Multiple myeloma	NR	Active tx	Exercise, sleep, fatigue, mood, activity, muscle strength, aerobic capacity	Wrist actigraph, sleep log, Epworth Sleepiness Scale
Couzi et al[60]	Medicine, psychiatry, public health	Descriptive	Breast cancer	0–III	Post-tx	Menopausal symptoms, willingness to take estrogen therapy	66-Item questionnaire with single-item sleep question

continues

Table 1 • continued

Source	Disciplines of Authors	Type of Study	Sample	Stage of Cancer	Cancer tx Status	Variables of Interest	Measure of Sleep-Wake
Crandall et al[7]	Medicine, public health	Descriptive	Breast cancer	0–IIIa	Post-tx	Severity, bother of menopausal symptoms—sleep, hot flashes, urogenital, sexual, cancer-related pain, cognitive functioning, depression, menopausal status	Generic questionnaire with one question regarding restless sleep
Davidson et al[28]	Psychology, medicine	Intervention	Mixed sample of cancer	NR	Post-tx	Sleep disturbances as insomnia, mood, functioning	Sleep diary, wrist actigraph
Davidson et al[5]	Psychology, medicine	Descriptive	Mixed sample of cancer	NR	Active or post-tx	Sleep disturbances, insomnia, fatigue, daytime sleepiness, sleep-related breathing problem, restless legs, dreaming, napping, use of sleep medications	Sleep Survey
de Moor et al[14]	Behavioral medicine, biostatistics, psychiatry, medicine	Intervention	Renal cell cancer	Metastatic	Active tx	Expressive writing, psychological, behavioral adjustment	Pittsburgh Sleep Quality Index
Dirksen and Epstein, 2008	Nursing	Intervention	Breast cancer	I–III	Post-tx	Insomnia, cognitive behavioral intervention, quality of life	Insomnia Severity Index
Engstrom et al[29]	Nursing, psychiatry	Descriptive	Mixed sample of cancer	NR	Active or post-tx	Sleep disturbances, mood, performance, daytime functioning, physical activity, lifestyle behaviors	Study specific 82-item sleep disturbance questionnaire, qualitative interview specific to sleep
Espie et al[62]	Psychology, medicine	Intervention	Mixed sample of cancer	NR	Post-tx	Insomnia, fatigue, cognitive behavioral intervention, quality of life	Pittsburgh Sleep Quality Index, Epworth Sleepiness Scale
Fernandes et al[63]	General science, medicine	Descriptive	Mixed sample of cancer	Advanced disease	Active or post-tx	Fatigue, daytime activity, sleep disorders, circadian rhythm	Wrist actigraph, sleep diary
Fortner et al[11]	Psychology, medicine	Descriptive	Breast cancer	NR	Pre-tx, active, or post-tx	Sleep, quality of life, cancer treatment	Pittsburgh Sleep Quality Index
Haghighat et al[64]	Medicine, public health	Descriptive	Breast cancer	I–IV	Active or post-tx	Fatigue, contributing factors of fatigue	General physical symptom questionnaire
Hunter et al[65]	Psychology, medicine, psychiatry	Descriptive	Breast cancer	No active cancer	Hormonal tx	Menopausal symptoms (eg, hot flashes, sleep), quality of life, management strategies	Women's Health Questionnaire
Janz et al[66]	Health behaviors/ education, medicine, public health	Descriptive	Breast Cancer	0–II	Post-tx	Symptom experience post-tx, quality of life	European Organization for Research of Cancer Quality of Life Questionnaire (EORTC QLQ-C30)

Koopman et al[30]	Psychology, medicine	Descriptive	Breast cancer	Metastatic/locally advanced	Active or post-tx	Sleep disturbances, depression, social support, cortisol levels	Sleep questionnaire (modified version of insomnia interview)
Lamb[42]	Nursing	Descriptive	Mixed sample of cancer	Active-tx or supportive care	NR	Sleep, hospitalization, cancer diagnosis	Study specific sleep questionnaire with items, open-ended questions
Le Guen et al[45]	Medicine	Descriptive	Lung cancer	Small cell (limited to extensive), non–small cell (stages I–IV)	Pre-tx	Sleep disturbances, daytime functioning	Pittsburgh Sleep Quality Index, Epworth Sleepiness Scale, wrist actigraph
Lis et al[46]	Public health	Descriptive	Mixed sample of cancer	I–IV	Pre-tx or active tx	Insomnia, patient satisfaction, quality of life	Insomnia subscale of EORTC QLQ
Malone et al[47]	Pharmacy, medicine	Descriptive	Mixed sample of cancer	NR	Active-tx	Quality of life (work, recreation, home management, sleep), health status	UK Sickness Impact Profile
Mao et al[48]	Medicine, biostatistics	Descriptive	Mixed sample of cancer	NR	Post-tx	Pain, depression, anxiety, insomnia, cancer survivorship, impact of symptom burden, age, comorbidity	Items from the National Health Interview survey
Miaskowski and Lee[31]	Nursing	Descriptive	Mixed sample of cancer	Metastatic	Active-tx	Fatigue, pain, sleep disturbance, depression	Sleep diary, wrist actigraph
Monga et al[49]	Medicine, psychology	Descriptive	Prostate cancer	T1c-T2c	Active-tx	Neuromuscular fatigue, sleep, depression, radiation tx	Epworth Sleepiness Scale
Okuyama et al[50]	Psychiatry, medicine	Descriptive	Breast cancer	0–III	Post-tx	Fatigue, correlates of fatigue, depression, coping, physical symptoms such as sleep	Physical symptom questionnaire
Owen et al[32]	Nursing	Descriptive	Mixed sample of cancer	NR	Active or post-tx	Sleep quality	Pittsburgh Sleep Quality Index
Parker et al[53]	Nursing, medicine	Descriptive	Mixed sample of cancer	III–IV	NR	Sleep-wake patterns, advanced cancer, medications	Polysomnography
Pud et al[58]	Nursing, psychology	Descriptive	Mixed sample of cancer	NR	Active tx	Fatigue, sleep disturbance, depression, pain, quality of life	General sleep disturbance scale
Quesnel et al[39]	Psychology	Intervention	Breast cancer	I–III	Post-tx	Insomnia, depression, state/trait anxiety, fatigue, quality of life	Insomnia Severity Index, polysomnography
Roscoe et al[34]	Psychology, medicine	Descriptive	Breast cancer	NR	Active tx	Fatigue, circadian rhythms, depression, mood, type of cancer treatment	Wrist actigraph

continues

Table 1 • continued

Source	Disciplines of Authors	Type of Study	Sample	Stage of Cancer	Cancer tx Status	Variables of Interest	Measure of Sleep-Wake
Savard et al[3]	Psychology	Descriptive	Breast cancer	I–III	Post-tx	Insomnia, contributing factors of insomnia	Insomnia Screening Questionnaire, Insomnia Interview Schedule
Savard et al[33]	Psychology	Descriptive	Breast cancer	I–III	Post-tx	Insomnia, nocturnal hot flashes, sleep disturbances	Insomnia Interview Schedule
Savard et al[38]	Psychology	Intervention	Breast cancer	I–III	Post-tx	Insomnia, anxiety, depression, fatigue, quality of life	Insomnia Interview Schedule, Insomnia Severity Index, Sleep Diary, polysomnography
Servaes et al[43]	Psychology, medicine	Descriptive	Breast cancer	NR	Post-tx	Fatigue, determinates of fatigue	Groninger Sleep Quality Scale
Schultz et al[9]	Nursing, medicine	Descriptive	Breast cancer	NR	Post-tx	Menopausal symptoms, physiological health effects related to cancer treatment, quality of life	Menopausal symptom questionnaire
Shapiro et al[42]	Psychology, medicine/ public health	Intervention	Breast cancer	II	Post-tx	Sleep disturbance, mood, worry, depression, state/ trait anxiety, type of cancer treatment, sense of coherence, control	Sleep diary
Silberfarb et al[51]	Psychiatry, psychology	Descriptive	Lung cancer	NR	Active-tx	Insomnia, sleep, cancer	Pittsburgh Sleep Quality Index, sleep log
Silberfarb et al[35]	Psychiatry, psychology	Descriptive	Mixed sample of cancer	I–IV	Post-tx	Sleep disturbance as insomnia, anxiety, mood, strength, depression, nausea, pain, fatigue	Polysomnography
Simeit et al[36]	Psychology	Intervention	Mixed sample of cancer	NR	Post-tx	Sleep management, cancer-related quality of life	Pittsburgh Sleep Quality Index
Spelten et al[41]	Medicine, psychology	Descriptive	Mixed sample of cancer	NR	Active and post-tx	Fatigue, depression, sleep, physical problems, cognitive dysfunction, psychological distress, return to work	Pittsburgh Sleep Quality Index
Tatrow et al[37]	Behavioral medicine	Descriptive	Breast cancer	NR	Active tx	Sleep, activity, distress, quality of life, fatigue, activity	Three-item sleep-wake assessment
Wang et al[40]	Nursing, medicine, biostatistics	Descriptive	Mixed sample of cancer	III–IV	Active tx	Pain, sleep disturbance	Pittsburgh Sleep Quality Index

Abbreviations: NR, not reported; tx, treatment.

Table 2 • Summary of Studies With a Theory, Model, or Framework

Source	Theory, Model, or Framework	Disciplines of Authors	Type of Study	Sample	Stage of Cancer	Cancer tx Status	Variables of Interest	Measure of Sleep-Wake
Berger[78]	Piper's Integrated Fatigue Model	Nursing	Descriptive	Breast cancer	I–II	Active tx	Fatigue, activity/rest, cancer treatment	Wrist actigraph
Berger and Higginbotham[79]	Piper's Integrated Fatigue Model	Nursing	Descriptive	Breast cancer	I-II	Active tx	Fatigue, sleep, activity/rest, symptom distress, health status	Morin Sleep Diary, wrist actigraph
Berger et al[70]	Piper's Integrated Fatigue Model	Nursing	Intervention	Breast cancer	I–II	Active tx	Fatigue, sleep, activity, chemotherapy, sleep hygiene intervention	Pittsburgh Sleep Quality Index, Brief Sleep History, Sleep Hygiene Awareness, Practice Scale, wrist actigraph, Morin Sleep Diary
Berger et al[15]	Piper's Integrated Fatigue Model	Nursing	Intervention	Breast cancer	I–II	Active or post-tx	Fatigue, sleep disturbance, adherence, sleep hygiene	Pittsburgh Sleep Quality Index, wrist actigraph, Morin Sleep Diary
Berger et al[68]	Piper's Integrated Fatigue Model	Nursing	Descriptive	Breast cancer	I–IIIa	Pre-tx	Fatigue, sleep-wake, activity-rest, circadian rhythms	Pittsburgh Sleep Quality Index, wrist actigraph, sleep diary
Blesch et al[76]	Piper's Integrated Fatigue Model	Nursing	Descriptive	Breast and lung cancer	NR	Active-tx	Fatigue, correlates of fatigue	Two-item sleep questionnaire regarding hours of sleep obtained at home, during hospitalization
Carlson et al, 2007	Biobehavioral Model of Altered Dysregulation in Circadian Systems	Medicine and psychology	Descriptive	Breast cancer	I–IV	Post-tx	Sleep quality, cortisol, melatonin, catecholamines, psychosocial stress/factors	Pittsburgh Sleep Quality Index
Carpenter and Andrykowski[6]	Model of Symptom Management	Nursing and behavioral science	Descriptive	Breast cancer	0–III	Post-tx	Menopause, menopausal symptoms, quality of life	Blatt Menopausal Index
Carpenter et al[2]	Theory of Unpleasant Symptoms—adapted	Nursing	Descriptive	Breast cancer	I–III	Post-tx	Hot flashes, sleep, fatigue, depression	Pittsburgh Sleep Quality Index
Carpenter et al[72]	Psychobiological model of hot flashes	Nursing	Intervention	Breast cancer	0–III	Post-tx	Hot flashes, sleep, mood	Pittsburgh Sleep Quality Index, wrist actigraph
Dodd et al[77]	Model of Symptom Management	Nursing and psychology	Descriptive	Mixed sample of cancer	Metastatic and nonmetastatic	Active tx	Symptom cluster, symptom outcomes, functional status, pain, fatigue, sleep insufficiency	Quality of Life—Cancer

continues

Table 2 • continued

Source	Theory, Model, or Framework	Disciplines of Authors	Type of Study	Sample	Stage of Cancer	Cancer tx Status	Variables of Interest	Measure of Sleep-Wake
Dow et al[12]	Model of Quality of Life	Nursing	Descriptive	Breast cancer	0–IV	Active and post-tx	Quality of life, physical, psychological, social, spiritual domains of quality of life	Quality of Life—Cancer
Epstein and Dirksen[73]	Spielman's Three-Factor Model	Nursing	Intervention	Breast cancer	I–III	Post-tx	Cognitive-behavioral intervention, insomnia	Sleep Diary, wrist actigraph
Hoffman et al[81]	Theory of Unpleasant Symptoms	Nursing and psychology	Descriptive	Lung cancer	I–IV	Active tx	Symptom cluster: pain, fatigue, insomnia	Cancer Symptom Experience Inventory
McMillan et al[97]	Orem's Self-care Deficit Theory of Nursing	Nursing	Descriptive	Mixed sample of cancer	Any stage	NR	Pain, sleep disturbance, depression	Memorial Symptom Assessment Scale
Payne et al[69]	Neuroendocrine-Based Regulatory Fatigue Model	Nursing and medicine	Descriptive	Breast cancer	II	Active tx	Fatigue, sleep, depressive symptoms, biomarkers	Demographic questionnaire (sleep disturbance), Piper Fatigue Scale (sleep disturbance item), wrist actigraph
Payne et al[80]	Neuroendocrine-Based Regulatory Fatigue Model	Nursing, medicine, and biostatistics	Intervention	Breast cancer	NR	Post-tx (hormonal tx)	Fatigue, waking intervention, sleep disturbances, depressive symptoms, biomarkers, symptom management	Pittsburgh Sleep Quality Index
Redeker et al[74]	Theory of Unpleasant Symptoms	Nursing	Descriptive	Mixed sample of cancer	Majority metastatic	Active tx	Insomnia, fatigue, anxiety, depression, quality of life	Symptom Distress Scale
Rhodes et al[82]	Orem's Self-care Deficit Theory of Nursing	Nursing	Qualitative	Mixed sample of cancer	NR	Post-tx	Tiredness, weakness, self-care	Self-care interview
Rumble et al[67]	Spielman's Three-Factor Model	Psychology, psychiatry, and medicine	Descriptive	Lung cancer	I–IIIa, limited stage small cell lung cancer	NR	Insomnia, sleep hygiene, cancer symptoms, mood, quality of life	Structured Interview for Sleep Disorders, Sleep Hygiene Practice Scale, Insomnia Symptom Questionnaire, sleep log, wrist actigraph
Vena et al[1]	Adapted Two-Process Model of Sleep Regulation	Nursing, psychology, and medicine	Descriptive	Lung cancer	Advanced disease	Active tx	Sleep-wake disturbances, quality of life	Pittsburgh Sleep Quality Index, Epworth Sleepiness Scale
Young-McCaughan et al[75]	Roy Adaptation Model	Nursing, biostatistics, psychology, medicine	Intervention	Mixed sample of cancer	0–IV	Active or post-tx	Exercise tolerance, activity, sleep patterns, quality of life	Wrist actigraph

Abbreviation: tx, treatment.

MODEL OF SYMPTOM MANAGEMENT

The Model of Symptom Management was a nursing model developed by nursing faculty from the University of California San Francisco's Center for Symptom Management.[89] The conceptual model is based on the premise that a symptom is a subjective experience of a biophysical function, cognition, or sensation. Starting with the symptom experience, 3 inner relationships include the perception of the symptom, the evaluation of the symptom, and the response of the symptom, which is related back to the perception. The response then includes internal feelings, behaviors, or thoughts related to the perceived or actual presence of a health problem. Symptom management strategies are actions that overcome or stop the negative outcomes from the symptoms through medical or self-care interventions such as assessment and treatment. The outcome of the symptoms is a complex construct that includes 10 possible dimensions.[89] In this model, sleep-wake disturbances can be a symptom or an outcome. This model was included in 2 articles.[6,12]

Table 3 • Comparisons Between Articles Without a Theory, Model, or Framework (n = 51) and Articles With a Theory, Model, or Framework (n = 22)

	Without Theory, Model, or Framework, n (%)	With Theory, Model, or Framework, n (%)	P[a]
Author Disciplines Included Nursing			
No	38 (75)	2 (9)	**<.001**
Yes	13 (25)	20 (91)	
Types of Study			
Descriptive	40 (78)	16 (73)	.59
Intervention	11 (22)	6 (27)	
Sample: cancer diagnoses			
Mixed sample	20 (39)	6 (27)	.53
Breast only	23 (45)	13 (59)	
Other single cancer	8 (16)	3 (14)	
Sample: stage of cancer			
Nonmetastatic	16 (31)	11 (50)	.21
Metastatic	5 (10)	2 (9)	
Both	11 (22)	6 (27)	
Not reported	19 (37)	3 (14)	
Sample: treatment status			
Pretreatment	2 (4)	1 (5)	.60
Active treatment	12 (24)	9 (41)	
Posttreatment[b]	21 (41)	7 (32)	
Mixed sample	12 (24)	3 (14)	
Not reported	4 (8)	2 (9)	
Pittsburgh Sleep Quality Index included			
No	38 (75)	14 (64)	.35
Yes	13 (25)	8 (36)	
Polysomnography used			
No	46 (90)	22 (100)	.13
Yes	5 (10)	0 (0)	
Actigraphy used			
No	43 (84)	12 (55)	**.01**
Yes	8 (16)	10 (45)	

Significant differences are in bold.
[a] P value based on χ^2 test of differences between groups.
[b] Posttreatment included subjects taking hormonal therapy.

NEUROENDOCRINE-BASED REGULATORY FATIGUE MODEL

The Neuroendocrine-Based Regulatory Model was developed to describe mechanisms of fatigue in chronic illness.[93] Although thought to be a multidimensional concept, the model proposes that fatigue is strongly influenced by endocrine-based biochemicals such as tryptophan and melatonin. Any stress on the endocrine system creates biological effects that serve as markers for fatigue.[93] Antecedents of fatigue are stated to be either physiological (altered circadian rhythm of sleep/wake) or psychological (depression). The model proposes interventions that act as a mediator to reduce the impact of the antecedents on the endocrine system and improve fatigue. This model was used in 2 articles.[69,80]

OREM'S SELF-CARE DEFICIT THEORY OF NURSING

Orem's Self-care Deficit Theory of Nursing was developed in 1985 and focuses on the ability of an individual to perform self-care activities (termed *self-care agency*) to maintain life, health, and well-being or the ability to care for others (termed *dependent-care agency*).[20,84] The nursing role within the model is to assess the individual's ability to perform self-care through a complete assessment of the current health state and symptoms being experienced by the individual. The model suggests that nurses provide 3 types of care: (1) total compensatory where the nurse provides total care when the individual cannot perform any self-care, (2) partial compensatory where the individual and nurse share self-care activities, and (3) supportive care or educational care where the nurse facilitates self-care through educating the individual with the tools to make decisions or learn skills needed for total self-care.[20,84] In this model, sleep-wake disturbances are symptoms that can result from cancer treatment that potentially impact self-care. This theory was used in 2 articles.[82,97]

PIPER INTEGRATED FATIGUE MODEL

The Piper Integrated Fatigue Model has been used to study fatigue in relation to sleep disturbances in cancer patients.[15] The mid-range nursing model by Piper et al proposes a variety of factors as influencing subjective and objective manifestations of fatigue (see Piper et al[85] for the figure). Fatigue manifestations are divided into physiological, biochemical, and behavioral components. These components include physiological muscle fatigue, changes in behavioral work activity, and/or symptoms of depression, and they can occur in combination as fatigue becomes a chronic problem.[85] In this model, sleep-wake disturbances are one of several factors influencing fatigue. This model was included in 6 articles.[15,68,70,76,78,79]

PSYCHOBIOLOGICAL HOT FLASH MODEL

This model depicts sleep disturbances as an outcome of menopausal hot flashes. It shows relationships among physiological

Table 4 • Summary and Comparison of Theories, Models, and Frameworks

SWD	Model	Brief Synopsis	Physiological Components	Psychological Components	Behavioral Components
Primary	Biobehavioral Model of Altered Dysregulation in Circadian Systems	SWD manifested as circadian dysregulation	X	X	
Primary	Spielman's Three-Factor Model	Predisposing, precipitating, and perpetuating factors interact in insomnia	X	X	X
Primary	Adapted Two-Process Model of Sleep Regulation (adapted)	Process S and process C drive sleep and wakefulness	X	X	X
Secondary	Model of Quality of Life	Sleep as part of physical well-being, 1 of 4 quality of life domains	X	X	
Secondary	Model of Symptom Management	Symptom experience, symptom management and symptom outcomes are related	X	X	X
Secondary	Neuroendocrine-Based Regulatory Fatigue Model	Describes mechanisms of wake disturbances (fatigue)	X	X	
Secondary	Orem's Self-care Deficit Theory of Nursing	SWD potentially impact self-care abilities	X	X	X
Secondary	Piper's Integrated Fatigue Model	Sleep as one of several factors influencing fatigue	X	X	X
Secondary	Psychobiological model of hot flashes	Sleep disturbances as outcome of menopausal hot flashes	X		
Secondary	Roy Adaptation Model	Sleep as physiological mode of adaptation	X	X	
Secondary	Theory of Unpleasant Symptoms—adapted	Physiological, psychological, and situational factors influence sleep and other symptoms that negatively affect performance status	X	X	X

Abbreviation: SWD, sleep wake disturbances.

hot flashes, perceived hot flashes, and the reporting of hot flash severity and bother, and it proposes that hot flashes contribute to a possible cluster of symptoms that include sleep-wake disturbances, mood disturbances, and changes in affect, which ultimately impact quality of life. This model was included in one article.[72]

ROY ADAPTATION MODEL

Roy Adaptation Model is a complex nursing model postulating that human beings have the ability to adapt to changes in the environment.[87] Adaptation or coping with environmental change occurs through maintaining 4 subsystems: (1) physiologic needs, (2) self-concept, (3) interdependence, and (4) role function. For nursing, the goal is to use this model to guide health promotion and adaptation to illness. The model postulates that focal, contextual, or residual stimuli can be manipulated to promote adaptation based on stage of personal development, family development, and culture.[87] Adaptation responses can be effective or ineffective depending on the mode of adaptation. Effective adaptation responses are thought to promote integrity of the human system.[87] In this model, sleep can be conceptualized as a physiological mode of adaptation alone or in combination with other outcomes.[75] This model was included in one article.[75]

THEORY OF UNPLEASANT SYMPTOMS

The Theory of Unpleasant Symptoms[83] is a mid-range nursing theory that has been used to describe sleep as it interacts with other symptoms. The theory has 3 interrelated components: (1) symptoms that the person experiences, (2) influencing factors that cause or affect the nature of the symptoms, and (3) consequences of the symptom experience.[83] Symptoms are the main component of the model and are measured in terms of intensity, quality, timing, and distress. The model posits that symptoms can occur alone or simultaneously with other symptoms and suggests that certain symptoms can catalyze

other symptoms (see Figure 2 in the study of Lenz et al[83]). Influencing factors are the physiological, psychological, and situational factors influenced by the symptoms. The third component is the consequence, defined as the impact of symptoms on an individual's ability to perform functional or cognitive activities. Functional performance includes activities such as physical, daily living, social, interactive, and role performance (eg, work) activities. The interaction among the 3 major concepts of symptoms, influencing factors, and consequences is reciprocal and can change as the symptom experience changes. This suggests that symptoms can moderate or mediate the relationship between influencing factors and performance.[83] In this model, sleep-wake disturbances can be one of many symptoms or an influencing factor affecting other symptoms. This model was included in 2 articles.[2,74]

■ Discussion

Quantification, Summary, and Comparison of Studies With and Without Explicitly Described Theories, Models, or Frameworks

The quantification of studies indicates that most research related to sleep-wake disturbances in cancer patients and survivors could be considered atheoretical. Most published studies that were reviewed here did not include an explicit description of a guiding theory, model, or framework. This is a significant limitation of existing research that may inhibit clarity of (1) the conceptual definition of sleep-wake disturbances, (2) the subsequent operationalization of sleep-wake disturbances, and (3) identification of contributing factors and consequences of sleep-wake disturbances.

The summary and comparison of studies indicated first that whether an article included a theory, model, or framework varied by discipline. Articles authored by nurses were significantly more likely to include an explicit description of a theory, model, or framework. It is well-known that nonnursing disciplines often do not disclose theoretical or conceptual models unless the purpose of the study is to further define the underlying concepts of the model. In addition, nonnursing journals may not allow space for the description of a theory or model. Therefore, one limitation of this review is that it is not known whether the studies were truly atheoretical or just lacking a written description of the theory, model, or framework.

The summary and comparison of studies also indicated that theoretically based articles were more likely to be based on subjective measurement rather than objective measures such as wrist actigraphy or polysomnography. Theories and models would seem to be equally relevant to subjective and objective measurement of sleep; however, exclusion of objective measures means that these theories and models are being tested only in the context of subjective sleep. In addition, the subjective measures that were used varied widely within both groups of studies (for details of sleep measures, see review[18]). Although the Pittsburgh Sleep Quality Index was the most commonly used measure of subjective sleep, most studies used other types of questionnaires to measure sleep-wake disturbances. This is also reflected by the various terminology of sleep such as *sleep-wake*, *insomnia*, *sleep disturbances*, *restless sleep*, and *tiredness*. Because of these variations in terminology and measurement, it is difficult to ascertain if sleep-wake disturbances were conceptualized similarly across studies that did not include theories or models.

The summary and comparison of studies did not show significant differences by group in terms of type of study (descriptive or intervention) and sample characteristics. These criteria varied widely within both groups of studies. Varying sample characteristics may make comparisons across studies somewhat difficult.

Summary and Comparison of Theories, Models, and Frameworks

This review revealed wide variation in the theories, models, and frameworks that are used to study sleep-wake disturbances in cancer. Several theories or models were only used in one study. The exceptions were Spielman's Three-Factor Model, the Model of Symptom Management, Orem's Self-care Deficit Theory, Piper's Integrated Fatigue Model, the Neuroendocrine-Based Regulatory Fatigue Model, and the Theory of Unpleasant Symptoms. These were each used in more than one study. In addition, when an author produced multiple works, he/she tended to consistently use the same model. For example, Berger et al[15,68–70,78,79] used the Piper's Integrated Fatigue Model and Payne[93] used the Neuroendocrine-Based Regulatory Fatigue Model in more than one study. On the other hand, Carpenter et al[2,6,72] used 3 different models for each of the studies reviewed. This illustrates that use of these theories may vary both within and between investigators and hypothesis driven.

Despite variation in the theories and models used, there were some commonalities. First, the theories and models overall are consistent with the idea that sleep disturbances are a combination of physiological, psychological, and behavioral phenomena.[71,86,88] Nine theories/models include physiological components,[71,72,84,85,88–90,93,94] eight included psychological components,[71,84,85,88–90,93,94] and six included behavioral components.[83–85,88,89,94,98]

In addition, the theories/models suggest that other symptoms may be a combination of components and/or consequences of sleep-wake disturbances. For example, when the Theory of Unpleasant Symptoms[83] was applied, it included psychological and/or physical symptoms as components of sleep-wake disturbances. When the Model of Symptom Management was applied, the co-occurrence of sleep-wake and other symptoms was emphasized.[6] The Piper model[85] included sleep-wake disturbances as a cofactor of fatigue, suggesting that fatigue might be a consequence of sleep disturbances. Other consequences of sleep-wake disturbances included performance status in the Lenz model and impact on wakefulness in other models.[88,94]

Finally, the models suggest that factors that contribute to sleep-wake disturbances are nonlinear; can change over time; and include predisposing, precipitating, and perpetuating factors.[94] Factors that initiate sleep disturbances (ie, predisposing or precipitating factors) may be different from those that lead to chronic sleep disturbances (ie, perpetuating factors). Thus, these models suggest that contributing factors should be reassessed over time.

Because of the high prevalence of sleep disturbances that contribute to poor quality of life in cancer patients, future research should focus on the development of a model or mid-range theory that is specific to the problem of sleep-wake disturbances in cancer. Such a model should include demographic, physiological, psychological, and behavioral factors of sleep disturbances and resulting health-related outcomes. In particular, cancer disease and treatment-related factors and other problems unique to this population should be included. For example, it is likely that women with breast cancer have unique health-related problems that might lead to sleep-wake disturbances (eg, premature menopause),[65] and these should be incorporated to increase model specificity. The model or theory should also account for symptoms as predisposing, co-occurring, or consequential phenomena. The theory/model also needs to clearly delineate the nonlinear nature of sleep disturbances. Finally, the model should consider the potentially broad impact of sleep and wake disturbances on physiological, psychological, behavioral, and social outcomes. Having a more specific conceptual model or theory for sleep-wake disturbances could help guide research by providing a mechanism that clearly defines and measures the concepts of sleep-wake disturbances in cancer. This would result in increased consistency among researchers by using similar types of measurement and similar variables increasing the ability to compare results across studies. Ultimately, a more specific model will provide researchers with a basis to facilitate symptom management through effective theory-based descriptive and interventions for this prominent problem in cancer.

■ Conclusion

In summary, although most existing research on sleep-wake disturbances in cancer does not include a description of a theory, model, or framework, several theories and models have been applied to this problem in this population at least once. The reviewed theories or models represent options that are available to guide research on sleep-wake disturbances in cancer populations. However, no one theory, model, or framework seems to provide an accurate picture of sleep-wake disturbances. Additional model or theory development is needed to enhance research that can be translated into improved clinical care in this area. It is recommended that authors should be encouraged to explicitly state the theory, model, or framework within the manuscript if one was used to guide the research. This could be accomplished through adding this type of reporting to publication guidelines to ensure that the readers can identify the conceptual underpinnings of the research.

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