Research using Rogers' conceptual system: development of a testable theorem

Judith A. Floyd, RN, PhD
Clinical Nurse Researcher
Lafayette Clinic
Detroit, Michigan

DEVELOPING A theoretical body of knowledge that can guide practice is a major task of nursing as it advances as a scientific discipline. Nurse researchers wishing to contribute to nursing theory development by testing nursing theories must deal with the fact that nursing's major theoretical formulations are primarily at the conceptual framework level of theory development. To use a conceptual framework to guide research requires the researcher to derive less abstract theoretical structures.

Fawcett[1] has recommended the reformulation of existing theories within nursing conceptual models as an effective way to derive theory. A testable theorem regarding the sleep-wakefulness rhythm was reformulated within Rogers' conceptual system.[2,3] Hypotheses were derived from the theorem and were tested in both a general and a clinical population. The methodological difficulties encountered

This work was supported in part by the Michigan Department of Mental Health Small Grants 80-16.

0161-9268/83/0052-0037$2.00

indicate that the best test of the theorem will occur in general population studies. However, descriptive studies of clinical populations also are useful, since they generate needed information about the recipients of nursing care and suggest relationships to be tested in more controlled settings.

DEVELOPMENT OF THE THEOREM

Rogers[2] emphasizes an open systems view of human beings and the environment as the conceptual basis for nursing science. *Energy field* is a central concept of Rogers' model. The human field and the environmental field are energy fields. Energy fields have no real boundaries; the pattern and organization identify them. An energy field is said to have meaning only in its entirety, since field behavior is unique and not understandable by a summation of behavior of the parts. Human and environmental fields are characterized by wave pattern and organization.

Three principles have been derived from Rogers' conceptual system: resonancy, helicy, and complementarity.[2,3] Resonancy and helicy are developed as central laws of interaction in this theoretical framework for sleep-wakefulness pattern research. The third principle, complementarity, is subsumed under the principle of helicy. Complementarity is addressed as a separate principle in Rogers' model to emphasize the difference between causal and probabilistic models of human development.[3] Complementarity is not addressed as a separate principle in this conceptualization. However, the mutuality of person-environment development is considered an integral aspect of the principle of helicy.

Resonancy

The principle of resonancy describes change as occurring through a rhythmic flow of waveforms that order and reorder the human and environmental fields. Rhythmic phenomena are considered expressions of the complementary relationship between human beings and their environment.[2,3] Rogers' conceptual system postulates that rhythmic repatterning develops in the direction of increasing complexity and diversity of rhythmic patterns and toward rhythms with increasing frequency. Furthermore, changes in human beings' rhythmic repatterning are postulated to occur more rapidly in response to disruptions in the person-environment interaction. Thus, one area for theory development suggested by Rogers' conceptual system is the nature of rhythmic interaction among evolving open systems.

A discussion of rhythmic phenomena and their interaction is facilitated by the use of a number of technical terms commonly accepted in rhythm theory. Any regularly oscillating process may be described as rhythmic or periodic. Terms applied to rhythms are *peak,* which is the maximum of the oscillation; *trough,* which is the minimum of the oscillation; and *cycle,* which is the shortest part of a rhythm that repeats itself indefinitely. The time occupied by a cycle is the *period.* The *amplitude* refers to either the actual or the mathematically estimated distance from trough to peak. A cycle can be measured from peak to peak, from trough to trough, or from any convenient point in one cycle to the corresponding point in the next. The number of cycles per unit of time is referred to as the *frequency* of the rhythm. A *phase* of a rhythm refers to any distinctive part of a cycle, such as the peak or the trough.[4,5]

The human sleep-wakefulness process can be conceptualized as a rhythm. The peak of each cycle of the sleep-wakefulness rhythm is the point of greatest wakefulness, and the trough is the point of deepest sleep. Research on human sleep-wakefulness patterns suggests that depth of sleep is rhythmic, with the deepest sleep, defined as stage 4 sleep, normally occurring in the first few hours of the sleep phase of the sleep-wakefulness cycle.[6] Although less research has been done on wakefulness, there is evidence that the degree of wakefulness is also rhythmic.[7]

Relaxation oscillation

Rhythms can be divided into two types, linear and nonlinear. *Nonlinear rhythms* are the type described by Rogers.[2,3] In a relaxation oscillation, one example of a nonlinear rhythm, a steadily rising or falling value for a variable crosses a threshold and then resets to a previous value. The siphon is a physical model of this type of nonlinear oscillation. Relaxation oscillations typically modify their period in response to environmental rhythms, but they tend to do so only over a narrow range of periods.[8]

In some ways the sleep-wakefulness rhythm functions as a relaxation oscillation. Some of the earlier sleep theorists sought to explain sleep and wakefulness as the result of an accumulation or depletion of humoral factors that were thought to be related to the phenomenon of tiredness.

Human beings are able to modify their sleep-wakefulness cycles in response to environmental rhythms, but tend to do so comfortably only over a narrow range of periods.

When the processes of sleep had neutralized the accumulated substance, or restored the depleted substance, wakefulness was postulated to return. An increase in physical activity or stressful experiences was thought to affect the critical level of the substance and, thereby, influence the sleep-wakefulness cycle. This biological model of sleep is supported by research reporting the isolation of substances that induce sleep.[9,10] Other evidence that the sleep-wakefulness cycle can be represented by a relaxation oscillation includes the empirical finding that human beings are able to modify their sleep-wakefulness cycles in response to environmental rhythms, but tend to do so comfortably only over a narrow range of periods.[11]

Limit-cycle oscillation

There are other aspects of sleep and wakefulness which suggest that a second type of nonlinear oscillation, called the limit-cycle oscillation, also may represent the human sleep-wakefulness rhythm. A nonlinear spring is a physical model of a limit-cycle oscillation.[8] The limit-cycle oscillation has three characteristics: (1) The limit-cycle oscillation does not show marked resonance, ie, the tendency for a rhythm's amplitude to increase at some preferred frequency; (2) if the frequency of a limit-cycle oscillation is gradually altered, sudden discontinuities in the amplitude of the rhythm will be observed; (3) the limit-cycle oscillation does not show superposition, ie, if two frequencies are applied to it simultaneously, the resulting rhythm is not the same as the sum of the separate rhythms.[8]

There is empirical evidence that the limit-cycle oscillation is a useful model for representing the sleep-wakefulness cycle. With regard to the statement that limit-cycle oscillations fail to show marked resonance, there is no evidence that the amplitude of the sleep-wakefulness cycle increases at some preferred frequency. If the sleep-wakefulness rhythm did show resonance, there should be evidence of deeper sleep and greater wakefulness in some kinds of sleep-wakefulness cycles. This has not been found by sleep researchers. Furthermore, a series of experiments conducted in underground bunkers demonstrated that depth of sleep, as well as peak of waking performance, is distributed when the light-darkness cycle is gradually altered to create artifically shortened or lengthened days.[4] This empirical finding is congruent with the statement that limit-cycle oscillations suddenly change amplitude when frequency is gradually modified. Finally, the research on recovery time following sleep deprivation demonstrates the nonadditive effect of hours of sleep deprivation on subsequent sleep needs.[12] This observation is congruent with the statement that limit-cycle oscillations fail to demonstrate superposition.

A view of the human sleep-wakefulness rhythm as a limit-cycle oscillation is congruent with Rogers' model of human field rhythmicity. The toy "Slinky," which Rogers suggested as a visual model of human field rhythmicity,[2] is a nonlinear spring and thus interacts with environmental forces in the manner described previously. When handling the toy one finds that the application of force results in changes in the frequency and direction of the spring but no increase in the width (amplitude) of the "Slinky" is observed.

The empirical evidence suggests that more than one nonlinear oscillation may be involved in what researchers observe to be the human sleep-wakefulness rhythm. Some aspects of sleep and wakefulness appear to be influenced by biological variables whose rhythms are best represented by a relaxation oscillation model. Other aspects of sleep and wakefulness appear to be influenced by variables, as yet unidentified, whose rhythms are best represented by a limit-cycle model. Whatever the specific number and nature of oscillations involved, the oscillations' tendencies to couple with one another is central to an understanding of sleep and wakefulness as a human field rhythm.

Helicy

The principle of helicy describes the nature and direction of change toward increasing complexity and diversity of human field pattern and organization and toward waveforms of increasing frequency.[2,3] In this conceptualization of waveforms, increasing frequency is subsumed under increasing complexity. Webster defines complexity in terms of "a whole made up of complicated or interrelated parts," and "a group of obviously related units of which the degree and nature of the relationship is imperfectly known."[13(pp 230,231)] Drawing from Webster's definitions, any process such as the sleep-wakefulness cycle can be considered to be increasing in complexity if it incorporates increasingly more units in its pattern and organization. When the units are the same as those initially present, the increase in complexity represents a quantitative change. When the units are different from those initially present, the increase in complexity involves a qualitative change.[14]

In discussing the two ways in which a process can increase in complexity, Werner[15] describes quantitative changes that are related to change in amount, frequency, and magnitude. Amount refers to absolute growth or increase in the number of occurrences of a specific unit, whereas frequency refers to an increase in the rate of occurrence per unit of time. Magnitude refers to growth in the size of each unit as distinguished from amount, which refers only to the number of units without reference to their size.

Qualitative changes can also be identified. According to Werner, qualitative change is concerned with the kind or type of thing that exists and with whether something new has emerged in the process. In qualitative change something new comes about in development. Because it is qualitatively different from what came before, it cannot be reduced to what came before.[15] Flavell[16] discusses the outcomes of qualitative change and identifies three possibilities: (1) The new unit can coexist with the old; (2) it can replace the old; or (3) it can modify the old such that the new unit appears to be an improved, matured, or perfected version of the old.

Predicted changes

A number of quantitative and qualitative changes in the sleep-wakefulness rhythm can be predicted from Rogers' principle of helicy. The first prediction is that the amount of wakefulness will increase with development. The amount of wakefulness, rather than the amount of sleep, is predicted to increase, since Rogers' conceptual system postulates change in the direction of increasing wakefulness.

The second prediction is that the number of sleep-wakefulness cycles per unit of time will increase with development. It has been noted that among retired persons there is a tendency toward a polyphasic way of alternating naps and waking.[17] In addition, Webb[18] has reported that napping among young adults is much higher than usually recognized. Eighty-five percent of his subjects reported napping. It is also noteworthy that in a number of cultures the afternoon nap is the custom rather than the exception.

The third prediction states that within a given sleep-wakefulness cycle, both the length of sleep and the length of wakefulness will increase with development. Some evidence of this change has been reported by Conroy and Mills.[4] They reported that about 1 person in 20 moved to an approximate 48-hour sleep-wakefulness cycle—for instance, 36 hours awake and 12 hours asleep—when environmental cues to day and night were removed.

Qualitative changes

The increasing complexity described by Rogers also may manifest itself in qualitative changes in the sleep-wakefulness rhythm. A fourth prediction is that change in the quality of the sleep-wakefulness cycle occurs; ie, new elements emerge with development. These new elements may coexist, replace, or modify the old elements. The old elements in this case are sleep and wakefulness. A review of the literature on altered states of consciousness[19] suggests that states beyond the usual understanding of wakefulness, or "beyond waking," are emerging.[2]

The four predictions involve increasing complexity of the waveform pattern and organization of the human sleep-wakefulness cycle. In addition, diversity among the waveform pattern and organization is postulated by Rogers' principle of helicy. A statement of a prediction based on increasing diversity in the human sleep-wakefulness cycle is as follows: Within the human population the types of sleep-wakefulness patterns are increasing. Some evidence of this change is manifest in the increasing range of hours in which one can work, recreate, shop, or conduct business. The identification of morning versus evening types of people[20] lends support to this prediction, as does the recently discussed phenomenon of night people.

Changes in human sleep-wakefulness patterns are manifest in the increasing range of hours in which one can work, recreate, shop, or conduct business.

Framework for study

The way in which Rogers' conceptual system guides the study of sleep-wakefulness patterns can be summarized in the following manner: In Rogers' system human beings and their environment are energy fields identifiable by their pattern and organization. Three principles—resonancy, helicy, and complementarity—describe the process, nature, and direction of change within energy fields. Since life's rhythms are integral to and inseparable from environmental rhythms, deviations in the rhythmic relationship between human beings and their environment are postulated to manifest themselves in disruption and reorganization of the human and environmental fields directed toward the evolution of a new rhythmical relationship.[2,3] The focus of sleep-wakefulness pattern research using this theoretical framework is the nature of sleep-wakefulness rhythm repatterning during deviations in the rhythmic relationship between human beings and their environment.

The prior discussion develops a theoretical framework for the study of one human field rhythm: the sleep-wakefulness rhythm. The theoretical framework was derived using Rogers' conceptual system as the organizing framework for reformulating the rhythm perspective. Developmental concepts and findings from research in the area of sleep and wakefulness were used to guide the reformulation. A reformulation was required, since some incongruencies between the rhythm perspective and Rogers' conceptual system exist.[5] One incongruency is the lack of any postulate within the rhythm perspective encompassing the direction of change in waveform repatterning. Rogers' principle of helicy identifies the direction of change, but within the rhythm framework no similar principle has been developed. Without reformulation, no predictions can be made about the developmental outcomes of waveform repatterning.

Testable theorem

A testable theorem has been deduced and is stated as follows: Persons experiencing a deviation in the rhythmic relationship with their environment will manifest greater complexity and diversity in their sleep-wakefulness patterns than persons who are not experiencing a deviation in the rhythmic relationship with their environment. There are a number of ways in which this theorem can be tested. For instance, deviations in the person-environment interaction resulting from the experience of hospitalization or shift work can be studied. Each of the five predictions regarding increasing complexity and diversity of the sleep-wakefulness rhythm can be operationalized and tested.

Two studies designed to test the theorem are described. The focus of the first study is shift work as experienced by adults employed in a variety of settings. The second study focuses on hospitalization as experienced by adult psychiatric patients. The studies demonstrate the operationalization and test the first two predictions regarding increasing complexity and diversity of the sleep-wakefulness rhythm: (1) The amount of wakefulness will increase; (2) the frequency of sleep-wakefulness cycles will increase.

THE SHIFT WORKER STUDY

The purpose of this study was to test hypotheses derived from the theorem that shift rotation is the source of environmental disruption. Four hypotheses were addressed. The first two hypotheses represent tests of increasing complexity in human sleep-wakefulness rhythms; the second two hypotheses represent tests of increasing diversity in human sleep-wakefulness rhythms.

1. Rotating shift workers will report more total wakefulness time than nonrotating shiftworkers.
2. Rotating shiftworkers will report a higher frequency of sleep-wakefulness cycles than nonrotating shift workers.
3. Rotating shift workers will report greater variance in total wakefulness time than nonrotating shift workers.
4. Rotating shift workers will report greater variance in frequency of sleep-wakefulness cycles than nonrotating shift workers.

Rotating shift workers were defined as those who do not routinely work one shift exclusively. Nonrotating shift workers were defined as those who routinely work only one shift, i.e., days, afternoons, or nights. Total wakefulness time was defined as the amount of time the subjects reported being awake per 24-hour period. Frequency of sleep-wakefulness cycles was defined as the number of times per 24 hours the subjects reported a period of sleep followed by a period of wakefulness.

The subjects were 60 volunteers who work in settings with day, afternoon, and night shifts including factories, airports, and health care settings. Thirty rotating shift workers and 30 nonrotating shift workers were interviewed regarding their usual sleep-wakefulness patterns. In each group of 30, 10 subjects filled out a sleep chart while working days, 10 subjects filled out a sleep chart while working afternoons, and 10 subjects filled out a sleep chart while working nights. Rotating shift workers were working a shift to which they had been rotated within the previous 24 hours; nonrotating shift workers were working a shift to which they had been assigned a minimum of 4 months.

Study instrument

The instrument used for recording sleep and wakefulness was a modified form of a sleep chart originally developed by Lewis and Masterton.[21] The issue of subjective measurement of sleep patterns is a major one in that such techniques rely on estimations of various times and durations. Efforts have been made to establish the validity of subjective measures of sleep and wakefulness. Baekeland and Hoy,[22] in evaluating an instrument similar to the Lewis and Masterton sleep chart, found that subjects were able to estimate awakenings greater than 4 minutes in duration without differing significantly from recorded electroencephalograph patterns. Browman and Tepas[23] also evaluated a similar sleep chart and reported that subjective estimates of time spent in bed before falling asleep, awakenings during the night, and total sleep time were not significantly different from electrophysiological estimates of these parameters.

The statistical design of the study was a 2 × 3 factorial with two dependent measures. The first factor, worker status, had two levels: rotating and nonrotating. The second factor was the shift worked during the time the sleep chart was completed. There were three levels of this factor: day, afternoon, and night. The two dependent measures were quantitative aspects of the sleep-wakefulness rhythm: total wakefulness time and frequency of sleep-wakefulness cycles.

Extraneous variables demonstrated to be related to the dependent variables are gender, age, and drug use.[24-27] The groups were matched on gender and age. The first two hypotheses were tested using analysis of covariance, with drug effects specified as a covariate. Drug effect scores were obtained from biological psychiatrists who rated the expected effects on sleep-wakefulness pattern variables of all drugs used by subjects during the study. Interrater reliability ranged from .79 to .86. The second two hypotheses were tested using Hartley's test for the homogeneity of variance.[28] Alpha was set at .05.

Results

The two hypotheses regarding increasing complexity were not significant at the .05 level. However, there were trends in the predicted directions for both hypotheses. Rotating shift workers slept an average of .33 hour less than nonrotating shift workers, $F(1, 53) = 3.89, p < .10$. Similarly, there was a trend toward rotating shift workers reporting a higher frequency of sleep-wakefulness cycles than nonrotating shift workers, $F(1, 53) = 3.53, p < .10$.

The two hypotheses regarding increasing diversity were both statistically significant. The variance on total wakefulness time was greater for the rotating shift workers than for the nonrotating shift workers, $F_{MAX}(2, 59) = 2.71, p < .05$. The variance for frequency of sleep-wakefulness cycles also was greater for rotating shift workers than nonrotating shift workers, $F_{MAX}(2, 59) = 2.25, p < .05$.

The second factor, ie, the shift worked during the time the sleep chart was completed, also was not related to total wakefulness time nor frequency of sleep-wakefulness cycles. This indicates that the rotation of shifts, rather than the timing of the shift worked, may be a major factor in understanding the sleep-wakefulness patterns of shift workers.

THE PSYCHIATRIC HOSPITALIZATION STUDY

The purpose of this study was to test hypotheses derived from the theorem that hospitalization is the source of environmental disruption. Four hypotheses comparable to those tested in the shift worker study were tested. Hospitalized psychiatric patients were predicted to have more complex and diverse sleep-wakefulness rhythms than psychiatric outpatients, since the process of hospitalization was conceptualized as resulting in an encounter between the individual's sleep-wakefulness rhythm and a new environmental rest-activity pattern.

Rotation of shifts, rather than the timing of the shift worked, may be a major factor in understanding the sleep-wakefulness patterns of shift workers.

The literature review suggested that sleep-wakefulness patterns of psychiatric patients may be influenced by psychiatric diagnosis, gender, age, and medication.[24-27] Therefore, a matched-pairs design was used: Hospitalized subjects were matched pairwise with outpatient controls on the variables of psychiatric diagnosis and gender. Age and drug effects were specified as covariates. As with the shift worker study, covariate scores were obtained from physicians' ratings. The "treatment" was hospitalization. The dependent variables were the two quantitative aspects of increasing complexity of the sleep-wakefulness rhythm: total wakefulness time and frequency of sleep-wakefulness cycles. Repeated-measures analysis of covariance and Hartley's test of homogeneity of variance were used to test the hypotheses.[28]

Setting and samples

The setting for the study was a small urban psychiatric hospital that serves as a research center for the public mental hospital system of a midwestern state. The hospital provides both inpatient and outpatient services. Data were collected from patients admitted to the adult inpatient wards of the hospital and from patients utilizing the outpatient services of the hospital.

The hospitalized sample consisted of the first 35 inpatients who agreed to participate in the study, were free from chronic illness other than psychiatric illness, and were mentally able to participate in the study as determined by the investigator's clinical judgment and consultation with ward staff. The control group consisted of the first 35 outpatient subjects matched to inpatient subjects on gender and diagnosis who agreed to participate in the study and who met the above criteria for inpatient subjects along with the following additional criteria: They must have at least one hospitalization for psychiatric problems; no hospitalization within the past 2 weeks; and no reported change in the timing of scheduled waking activities during the past 2 weeks. The inclusion criteria were designed to equate the two groups with regard to health status, including degree of psychiatric impairment, as well as rule out the occurrence among outpatient subjects of environmental disruptions comparable to hospitalization, such as shift work.

In this study, the validity of the sleep chart was established by comparing nursing records of the hospitalized subjects' sleep with their self-reports. Staff reported an inability to tell from observation whether subjects were asleep or awake in 3% of their observations. For those periods of time when the staff member was certain about the subject's sleeping or waking state, there were no discrepancies between staff and patient records of sleeping and waking.

Results

It was found that hospitalized subjects were awake nearly 1 hour more per 24-hour period than the matched outpatient subjects, $F(1, 33) = 4.78, p < .05$. Thus the first hypothesis, that hospitalized psychiatric patients will report more total wakefulness time than outpatient controls, was supported.

The second hypothesis, that the frequency of sleep-wakefulness cycles would be greater for hospitalized subjects than outpatient controls, was not supported. The third and fourth hypotheses, that hospitalized subjects would report more variance in total wakefulness time and frequency of sleep-wakefulness cycles, also were not supported.

DISCUSSION

The trends and significant findings of the shift worker study are interpreted as supportive of Rogers' conceptual system and the theoretical statements derived within that system, including the following assumptions:

- Human beings and their environment are evolving, open systems identifiable by their pattern and organization.
- Change in human and environmental fields occurs through the rhythmic flow of waveforms.
- The sleep-wakefulness rhythm represents one index of human field functioning.
- Total wakefulness time and frequency of sleep-wakefulness cycles are indicators of complexity and diversity in sleep-wakefulness patterns.
- Rotation of the shift being worked represents a deviation in the rhythmic relationship between human beings and their environment.

However, when the theorem was tested with a clinical population, only one of the hypotheses was supported. Possible explanations for this discrepancy between the two studies include uncontrolled situational variables in the clinical setting or spurious findings in the shift worker study. Since the findings from the shift worker study have not been replicated, it is possible that they represent type II error[29] or can be accounted for by some other variable. For instance, one limitation of the shift worker study was the failure to control for type of shift work being done. Some of the subjects were engaged in hard physical labor, which may be related to decreased total wakefulness time; other subjects were engaged in emotionally stressful work, which may be related to more frequent awakenings.[24]

Variables

One situational variable that is difficult to control is the effect of drugs on sleep-wakefulness patterns. Drug use among the shift workers was limited to caffeine, nicotine, and alcohol. The effects of these drugs on sleep-wakefulness patterns have recently been documented.[27,30-32] Statistical control of the effects of psychotropic drugs on the sleep-wakefulness pattern variables of interest in these studies is less well documented. They also are more difficult to predict, since it is necessary to deal with the effects of many more drugs as well as their interactions.

Additional stiuational variables that affect sleep-wakefulness pattern variables but that are difficult to control in the clinical setting include health status and environmental stimuli. Although the psychiatric subjects were matched on diagnosis and were drawn from a population that has experienced psychiatric hospitalization, acuteness of psychopathology and the effects of the subsequent treatment with psychotropic drugs are difficult to control with confidence. In addition, no information was gathered regarding the home environment of the outpatients. A number of environmental factors may have contributed to the failure to support more of the hypothesized differences between hospitalized and outpatient sleep-wakefulness patterns.

Testing of hypotheses

The reformulation of existing theories within nursing conceptual frameworks results in theoretical formulations that have not been empirically tested. The best test of hypotheses derived from these formulations is in settings with as few uncontrolled situational variables as possible. In research on sleep and wakefulness, general populations free from chronic illness and with minimal or no drug use would be ideal. Since such individuals are rarely hospitalized, hospitalization is ruled out as the best environmental disruption to be used for a major test of the theorem. Shift work studies, especially those in which the type of shift work is controlled, would appear to provide a better test of the theorem. If these shift work studies were done with nursing personnel, the research could also yield information useful to nursing in organizing optimal systems for around-the-clock delivery of nursing services.

Shift work studies with nursing personnel can yield information useful to nursing in organizing optimal systems for around-the-clock delivery of nursing services.

Although well-controlled tests of the theorem are difficult in clinical populations, sound descriptive studies of clinical populations' sleep-wakefulness patterns during hospitalization and on discharge to the community also are needed. The correlates of differing sleep-wakefulness patterns and the interaction of factors such as health status, medical treatment, and environmental stimuli all warrant exploration. Therefore, two approaches to research on sleep and wakefulness using Rogers' conceptual system are recommended: continued theory building by testing the theoretical formulations with populations that allow for the most control and descriptive studies, also guided by the conceptual system, of clinical populations.

REFERENCES

1. Fawcett J: The what of theory development, in *What, Why and How of Theory Development*. New York, National League of Nursing, 1978.
2. Rogers ME: *An Introduction to the Theoretical Basis of Nursing*. Philadelphia, FA Davis, 1970.
3. Rogers ME: Nursing: A science of unitary man, in Riehl JP, Roy C (eds): *Conceptual Models for Nursing Practice*, ed 2. New York, Appleton-Century-Crofts, 1980, pp 329-337.
4. Conroy RT, Mills JN: *Human Circadian Rhythms*. London, J & A Churchill, 1970.
5. Floyd JA: Rhythm theory: Relationship to nursing conceptual models, in Fitzpatrick J et al (eds): *Nursing Models and Their Psychiatric Mental Health Applications*. Bowie, Md, Robert J. Brady Co, 1982, pp 95-116.
6. Hartmann EL: *The Functions of Sleep*. New Haven, Conn, Yale University Press, 1973.
7. Klein R, Armitage R: Rhythms in human performance: $1^1/_2$-hour oscillations in cognitive style. *Sci* 1979;204:1326-1328.
8. Aschoff J: *Circadian Clocks*. Amsterdam, North-Holland, 1965.
9. Koella W: *Sleep: Its Nature and Physiological Organization*. Springfield, Ill, Charles C Thomas, 1967.
10. Pappenheimer JR: "Nature's soft nurse." A sleep-promoting factor isolated from brain. *Johns Hopkins Med J* 1979;145:49-56.
11. Czeisler CA: Chronotherapy: Resetting the circadian clock of patients with delayed sleep phase insomnia. *Sleep* 1981;4(1):1-21.
12. Dement W, Mitler MM, Zarcone VP: Some functional considerations in the study of sleep. *Psychosomatics* 1973;14:89-94.
13. GC Merriam Company: *Webster's New Collegiate Dictionary*. Springfield, Mass, 1976.
14. Lerner R: *Concepts and Theories of Human Development*. Reading, Mass, Addison-Wesley, 1976.
15. Werner H: *Comparative Psychology of Mental Development*. New York, International Universities Press, 1948.
16. Flavell J: An analysis of cognitive-developmental sequences. *Hum Dev* 1970;13:33-42.
17. Luce GG: *Biological Rhythms in Psychiatry and Medicine* (NIMH, US Public Health Service Publication No. 2088). Washington, DC, US Government Printing Office, 1970.
18. Webb WB: *Sleep—the Gentle Tyrant*. Englewood Cliffs, NJ, Prentice-Hall, 1975.
19. Tart CT (ed): *Altered States of Consciousness*. New York, John Wiley & Sons, 1972.
20. Horne JA, Ostberg O: Individual differences in human circadian rhythms. *Biol Psychol* 1977;5:179-190.
21. Lewis HE, Masterton JP: Sleep and wakefulness in the arctic. *Lancet* 1957;1:1262-1266.
22. Baekeland F, Hoy P: Reported vs. recorded sleep characteristics. *Arch Gen Psychiatry* 1971; 24:548-551.
23. Browman CP, Tepas DI: The effects of presleep activity on all night sleep. *Psychophysiology* 1976; 13:536-540.
24. Floyd JA: Hospitalization, sleep-wake patterns, and circadian type of psychiatric patients. Unpublished doctoral dissertation, Wayne State University, 1982.
25. Lavie P: Sleep habits and sleep disturbances in industrial workers in Israel. *Sleep* 1981;4:147-158.
26. Hauri P: *The Return to Sleep*. Kalamazoo, Mich, Upjohn Company, 1977.
27. Palmer CD, Harrison GA: Association between smoking and drinking and sleep duration. *Annals Human Biol* 1980;7:103-107.
28. Winer BJ: *Statistical Principles in Experimental Design*, ed 2. New York, McGraw-Hill, 1971.
29. Hayes WL: *Statistics for the Social Sciences*, ed 2. New York, Holt, Reinhart, & Winston Inc, 1973.
30. Nicholson AN, Stone BM: Effect of some stimulants on sleep in man. *Br. J. Pharmacol* 1979;66:476.
31. Soldatos CR, Kales JD, Scharf MB: Cigarette smoking associated with sleep difficulty. *Science* 1980; 207:551-553.
32. Stone BM: Sleep and low doses of alcohol. *Electroencephalog Clin Neurophysiol* 1980;48:706-709.