Environmental Enrichment and Nursing Therapy with Comatose Patients: Two Case Studies

Marilyne R. Sayler

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Abstract

ENVIRONMENTAL ENRICHMENT AND NURSING THERAPY WITH COMATOSE PATIENTS: TWO CASE STUDIES

by Marilyne R. Sayler

As a part of a larger research project with comatose patients, the problem stated for this portion of the research study was to investigate the potential for identifying whether or not the quality of nursing care for comatose patients could be improved by nursing therapy with environmental enrichment and meaningful systematic orienting stimuli given by professional nurse clinicians and a patient's significant others. The effects of the orienting stimuli were measured by observable changes in arousal patterns in serial electroencephalograms (EEGs), level of arousal as scored on the Glasgow Coma Scale (GCS), and selected measures of recovery outcome (RO).

Criteria for sample selection were developed to exclude patients who demonstrated electrocerebral silence and those who were reasonably expected to regain consciousness once their underlying metabolic disorder was corrected (as in patients with a diagnosis of drug overdose). The first two patients who qualified for inclusion in the study had both experienced traumatic head injuries as a result of vehicular accidents. The first patient was assigned to the clinical trial (experimental) group, the second to the clinical comparison (control) group several days later.

After the research staff determined the candidate met the sample criteria, consent was obtained from the patient's physician and next of
kin. At 72 hours or less after loss of consciousness (LOC) each patient was admitted to the study. An initial 10-montage EEG was done followed by daily 3-montage EEGs for the next 80 hours. During that time the experimental patient received systematic orienting stimuli and environmental enrichment every hour between 8 A.M. and 10 P.M. for 10 to 15 minutes. The family was encouraged to participate in providing these stimuli. The control patient did not receive systematic orienting stimuli from the research staff. However, after mingling with the experimental patient's family, the control patient's mother vigorously presented similar types of stimuli to her son as had been presented to the experimental patient.

Data collection for the study included recording hourly GCS scores, biophysical data (temperature, pulse, respiration and arterial mean) and pupillary size and reactivity. Biochemical data were also recorded when results of lab tests were available. Final 10-montage EEGs were done on the final day of the study, 14 and 17 days post onset of coma.

Because of the contamination of the clinical control group a case study approach was used to describe the clinical courses of both patients and to present the data. Thus this study became an extension of the pilot study for the larger research project.

The initial EEGs of the experimental patient showed predominant slow wave activity with occasional alpha and beta waves. Although a near normal pattern emerged by day 14, the same improvement was not seen in his GCS scores (4) and his clinical status (unresponsive except to deep pain). After 31 days in coma, the patient began regaining
consciousness. By day 37 he started verbalizing. After 66 days in a rehabilitation center he was discharged to home having demonstrated a good recovery with only a few limitations in articulation and fine motor movements.

The second patient, the control patient, experienced a less stable clinical course, and demonstrated intermittent increased intracranial pressure and some alterations in blood pH. As stated earlier, this patient received more than the routine ICU care, since his mother provided orienting stimuli similar to that received by the experimental patient. His EEGs showed a predominance of delta or slow wave activity with occasional alpha and theta rhythms and rare beta activity. The mean of his GCS scores at the end of the study was 9. After 32 days in coma the patient began to slowly regain consciousness. After spending 75 days at the rehabilitation center he was discharged to home. He had made a good recovery with only a few limitations, primarily in speech and mobility of the left upper extremity.

With only two patients in the sample, no conclusions were drawn. Even though the beneficial effect of orienting stimuli could not be demonstrated by immediate arousal movement on the EEG or GCS scores, some potential support for this intervention exists in that both patients made good recoveries at six months, despite the fact that they remained in prolonged deep coma with GCS scores of less than 8 or less than 4 most of the time. Previous investigators reported 95-99 percent of such patients die (Jennett; Teasdale, 1975, 1977).

A number of factors influenced the outcomes of this study. Standardizing the medical and nursing care received by the patients
was not possible. As known from the inception of the overall research project, factors such as the personalities, philosophies and education of the different nurses injected a number of uncontrollable variables. The continuity of care provided by regular neurosurgical follow-up varied with each patient. The research staff were unable to obtain blind scoring of the EEGs by the consulting neurologist. The inexperience of the EEG technician compounded by the noise of the intensive care unit affected the quality of the EEGs but did not render them unscorable.

Patient and family-related variables presented potential limitations. These included the extent and existence of precoma dysfunctions; the precoma abilities and psychological state of each patient including overwhelming recent stress or loss; history of use of cigarettes with or without Cannabis or PCP and/or misuse of drugs, alcohol, or other substances; and the ability, need and desire on the part of the family to provide meaningful orienting stimuli and environmental enrichment. As previously stated, the differentiation between the therapeutic treatments received by the control and experimental patients was obscured by the fact that the control patient's mother vigorously provided orienting stimuli to her son.

Other limitations included fatigue of the researchers, and rarely, the unavailability of the hospital's EEG machine. The extent of the influence of the research staff's presence on the care given to the patients by hospital staff was not assessible. Coinvestigators of the larger research project assisted the graduate student in this portion of their study.
Several nursing implications arose from the data collected. What effect did routine nursing care other than suctioning, systematic orienting stimuli (SOS), and environmental enrichment have upon the patient's intracranial pressure? How reliable were the polygraphs and other equipment in the ICU environment? Can the ethical dilemma of comatose patients in a control group be resolved? How assertive ought nurse researchers be in intervening to provide patients with more aggressive care when warranted by the patient's clinical status? These questions and many more related to this research must await future study for resolution.
ENVIRONMENTAL ENRICHMENT AND NURSING THERAPY WITH
COMATOSE PATIENTS: TWO CASE STUDIES

by

Marilyne Sayler

A Thesis in Partial Fulfillment
of the Requirements for the Degree
Master of Science in the Field of Nursing

June 1981
The persons whose signatures appear below certify that this thesis in their opinion is adequate, in scope and quality, as a thesis for the degree Master of Science.

Evelyn L. Elwell, Associate Professor of Nursing

Annette M. Ross, Associate Professor of Nursing

Darlene B. Johnson, Associate Professor of Nursing
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Chapter 1

DELINEATION OF THE PROBLEM

The accomplishments of research in the area of medical science remain undisputed. Based upon the reliability and predictability of past research findings, health care delivery has become increasingly sophisticated in many areas, for many types of human dysfunction. The overall picture is very impressive—control, cure, and even eradication of certain disease processes, shorter hospitalization for patients, and increased longevity for the population as a whole. The health care team stands ready to identify and in many cases to alleviate man's physical infirmities.

Background of the Study

But what of those processes which affect the conscious activity of man's center of behavior, intellect and emotion—the brain? The confidence and skills of health care providers often appear to shrink in the darkness and shadow which envelop the comatose patient. Here the issues become much more elusive; the outcome of "quantity" fades in the search for "quality" of survival. Measured against the probable prognosis of severe impairment or persistent vegetative state, even death itself may appear to be the preferred alternative when human suffering and cost are concerned. Caronna and Simon made the summary statement that "the outcome of coma is, in general, poor." (1979, p. 16)
Will this statement become a conclusion of finality or will it become an initial stepping-stone for enlightened care of the comatose patient? Short of rigorous, conscientious research, the former will certainly prevail.

There must be a more tangible resource than fate in dealing with comatose patients. Can the nursing profession, by directing its efforts toward providing the patient with reorienting stimuli, make a difference in the patient's level of arousal and eventual outcome? This is the question to be considered in this research project.

**Problem Statement and Purpose**

The problem stated for this study was to investigate the potential for identifying whether or not the quality of nursing care for comatose patients could be improved by nursing therapy with environmental enrichment and meaningful systematic orienting stimuli given by professional nurse clinicians and a patient's significant others as measured by observable changes in arousal patterns in serial electroencephalograms (EEGs), levels of arousal as scored on the Glasgow Coma Scale (GCS), and selected measures of recovery outcome. The overall purpose of this study was to begin investigation of methods to improve the quality of care of comatose patients with the eventual future goal of demonstrating the cost effectiveness of providing quality care earlier in the patient's hospitalization.

**Conceptual Assumptions and Rationale**

The conceptual basis for the overall study was not included in this report. The basis subsequently described was meant to provide the
rationale for communicating with the comatose patient through systematic orienting stimuli.

Research examining neural responses to cortical lesions supports the concept that in adult rats the lesioned brain has the capacity for reorganization by growing new synapses and by adjusting its circuitry. Called reactive synaptogenesis, it is important to note that this process is not a part of the normal course of neural development, but is rather a reaction to a stimulus (Cotman; Lynch, 1976, pp. 69-108; Cotman; Nadler, 1978, pp. 227-272). The full significance of this concept in relationship to the human brain awaits further research. But the evidence thus far suggests some implications for present medical and nursing care of comatose patients. If it is true that in humans "the adult brain has the capacity to dynamically reorganize its circuitry, . . . after brain damage this plasticity must be taken into account." (Cotman; McGaugh, 1980, p. 675)

What variables can produce a positive influence on neural plasticity? Rosenzweig and Bennet found that young rats benefited by being placed in an "enriched environment" such as housing in large cages, maze training, exposure to various toys, etc. (1976, pp. 179-213). This finding is plausible in the light of present understanding that it is electrical stimulation of the brain, particularly the brain stem reticular formation that produces arousal (Jouvert, 1967, pp. 529-544). It is reasonable to believe that such electrical stimulation need not be invasive, that it may effectively result from the introduction of external visual, auditory, tactile, olfactory and gustatory stimuli. If nursing intervention, directed at providing the comatose patient
with frequent and varied stimuli can elicit electrical activity in the reticular activating system, then the effects of that intervention should be measurable in terms of patient outcomes--an increase in the "conscious, alert state that makes perception possible." (Ganong, 1977, p. 120)

**Definition of Terms**

The key terms used in this study were defined for the purpose of the larger study of which this study was a part. Explanations were also included in some instances to assist in clarifying the definitions.

**Coma**

Coma was defined as a deep stage of unresponsiveness which designated a state of unconsciousness from which the subject could not be aroused. Coma was not equated with sleep, a state of unresponsiveness from which a subject can be aroused.

In coma, stimulation fails to produce voluntary neural response in the patient. Psychologic and motor responses are either completely lost or are reduced to rudimentary reflexes. The term coma is used interchangeably with unconsciousness (Moidel, and Others, 1976, p. 273). Irreversible coma is the sign of a permanently nonfunctioning brain (Macbryde; Blacklow, 1970, p. 671). The point at which coma becomes irreversible is a controversial one, unknown and unspecified for the purposes of the present project (Elwell; Ross, 1980).
Consciousness

Consciousness was defined as a generalized process of the functioning of the waking brain, and recognizable through introspection only and divisible into a state (or states) of awareness and a state of changing mental content to which humans attend. The mental content included items of both primary and subsidiary import and was evident either in present perception of (after recall) in the memory of past events. Phylogenetically, its origin was said to lie in feeling (Mac-Bryde; Blacklow, 1970, p. 671).

Electroencephalogram

The electroencephalogram (EEG) was defined as a diagnostic study that enables the physician to interpret the organization, rhythm, and rate of electrical activity of the brain. Similar to other cells of the body, the cells of the brain maintain an electrical charge or potential which may be altered by various diseases. By placing electrodes (small metal discs) in contact with the scalp with an electrode paste, small electrical potentials can be transmitted to the electroencephalograph which amplifies and converts these microvoltages into lines that are recorded on a rapidly moving roll of paper. There is no pain or danger of electrical shock during the procedure. The completed test will be interpreted by an electroencephalographer (a neurologist). (Schneider, 1980)

Electrode Placement by the 10-20 International System

Electrode placement by the 10-20 International System was defined as the patterns for orienting electrodes on the scalp for an EEG which would produce a tracing identical to one taken anywhere else in the world using the same patterns and patients. "The 10-20 System . . . is based upon measurements from four standards on the scalp: the nasion, the
inion, and the left and right pre-auricular points." (Cooper; Osselton; Shaw, 1969, pp. 76, 77) "Electrodes are placed in ten locations from which specific patterns of activity are obtained. These are the left and right frontal, midtemporal, anterior temporal, parietal (central), and occipital areas. Two reference electrodes" were placed (Gibbs; Gibbs, 1967, p. 5). The System was "designed to ensure that the inter-electrode spacings are equal along any anteroposterior or transverse line. It is precise and provides comprehensive coverage of the convexity of the hemisphere." (Cooper; Osselton; Shaw, 1969, pp. 76, 77) The 10-20 International System for Electrode Placement for recording EEGs was diagrammed in Figure 2 which was placed in Appendix H. The different patterns or combinations of referencing one electrode to another were termed montages and were further defined under "montages."

Environmental Enrichment

Environmental enrichment was defined as any systematic orienting stimuli, nursing therapy, or other beneficial activity or communication in the patient's milieu which would not produce a negative response, activity or feeling within the patient's mind or body and which had the potential to contribute to improving the quality of his survival.

The Glasgow Coma Scale (GCS)

The Glasgow Coma Scale was defined as a practical numerical scale for assessing impaired consciousness and coma. Developed by Teasdale and Jennett in 1974, it was designed to permit the assessor to assign a score for various combinations of eye opening, verbal and
motor responses (Teasdale; Jennett, 1974, pp. 81-84). A copy of the actual Glasgow Coma Scale was placed in Appendix B.

Montage

A montage was defined as one of several different patterns of referencing between EEG electrodes. Since the number of recording channels available on the electroencephalograph equipment was usually less than the number of electrodes applied to the patient's scalp, a complete recording could not be made from all the electrode combinations simultaneously (Cooper; Osselton; Shaw, 1969, p. 77). By using certain patterns in succession, a tracing of electrical activity from select portions of the brain was obtained. The montages used in this study were those chosen by the neurologist consultant.

The ten montages identified for the study were labeled from A to J. A full 10-montage EEG was done at the beginning of the study and the seventh to tenth day after the completion of the study. The daily EEG tracings completed between those times consisted of three montages, A, B, and C only. The actual list of montages used was tabulated in Table 8 which was placed in Appendix I.

Neurological Nurse Specialists

Neurological nurse specialists were defined as professional nurses with specialized training in neurological nursing care at the post-baccalaureate and/or post-master's level.

Program of Systematic Orienting Stimuli

The program of orienting stimuli was defined as possible types of orienting stimuli, nursing therapies, and environmental enrichments.
which could be used for reorienting the comatose patient (Elwell, 1977).

They were described as follows:

**TYPE I. Verbal explanations of conditions by nurse**

Appropriate, concise, verbal explanation of procedures, nursing therapy, nursing assessment, and/or environmental conditions were given.

**TYPE II. Voices of significant others tape**

This category of tape recording included voices of significant others with family news recorded on low noise 30-minute monoaural tapes. Recording was done on a standard tape recorder and played through earphones.

**TYPE III. Music Tape**

This category of tape recording included the playing of the patient's favorite music and did not exceed 15 minutes total per playing. In accordance with information gathered about the patient's known preferences, this might have included a classical symphony, a favorite opera, an acid rock or jazz work. In the event the patient was not a music lover an individualized substitute was found. For example, a favorite painting was discussed, or sounds of the ocean recorded and played.

**TYPE IV. Hobbies tape**

This category of tape recording included discussion of the patient's hobbies. The discussion was as individualized as possible, about 15 minutes in length. For example, if the patient was a stamp collector, bird watcher, gardener, artist, camper, hiker, photographer, sports enthusiast, etc., that special hobby was discussed.

**TYPE V. Current world events tape**

This category of tape recording included current events, news, and weather taped from television or played from AM radio directly for the patient through earphones. News was monitored prior to taping when necessary, i.e., in the event the patient was in an auto accident in which others died and it was broadcast in the news or other similar contingencies. The tape or time the radio was on did not exceed 15 minutes.
TYPE VI. Current events about patient's work/study

This category of tape recording included news or facts related to the patient's work, business or studies as obtained from patient's family. The tape did not exceed 15 minutes.

TYPE VII. Information tapes by research staff

This category of tape recording included pertinent information compiled in the event that no next of kin, neighbors, physician, old chart, etc., were available. Tapes were made by the principal investigator and nurse specialists and were appropriate for the age, sex, and marital status of the patient, and did not exceed 15 to 20 minutes.

TYPE VIII. Patient out of bed

In this type of nursing therapy the patient (condition and physician permitting) was gotten out of bed. Tube feeding if any was given while out of bed at least morning and evening.

TYPE IX. Taste stimulation

In this type of nursing therapy taste was stimulated at mealtime with lemon stick, grains of salt, and a favorite food (applicator dipped in if reasonable). At this time the patient's tube feeding was given if possible, so Types VIII and IX orienting stimuli were given together.

TYPE X. Touch by research staff

In this type of nursing therapy touch was used in the form of gentle pressure over the wrist when asked specific orienting questions--gentle pressure over the mandible or the angle of the jaw when giving orienting stimuli--gentle pressure over the iliac crest after the patient was turned.

TYPE XI. Smell--favorite of patient

In this type of nursing therapy favorite cologne, perfume, flowers, etc., were brought so that the patient could smell them. In the event that one of the patient's favorite smells was a food he/she was allowed to smell the food and if possible do so in conjunction with Types VIII and IX.

TYPE XII. Audio tape of patient's favorite TV program

In this type of nursing therapy an audio tape of the patient's favorite television program was made and played for 15 to 30 minutes at a time.
TYPE XIII. Feeling of familiar or favorite things, different textures

This type of nursing therapy included placing common items (keys, small books, etc.), different textures (smooth wooden figurine, corduroy, satin), children's favorite things (teddy bear, doll or blanket) in or on the hands of the patient.

TYPE XIV. Voice of mother only tape

In this type of tape recording the patient's mother was asked to make a tape recording telling anecdotes from the patient's past, encouraging patient to awaken, etc. These tapes were then played for the patient for 15 minutes. When the individual's mother was not available, the wife, closest female relative or friend was asked to make the tape.

TYPE XV. Reading favorite or familiar story

In this type of tape recording someone reading a favorite book or story was recorded and played for 15 minutes at a time.

TYPE XVI. Vital signs by research personnel for study purposes

In this category were included the nursing therapies performed by the nurse researchers to assess neurological and vital signs. The assessment and recording of blood pressure, pulse, respiration, temperature, pupil size and reactivity, level of consciousness and/or response, recording the EEG and placing electrodes for the EEG were also considered stimuli.

TYPE XVII. Auditory evoked response noise

In this category the usual method of stimulating the auditory evoked response was done using high and low pitched sounds, clapping loudly.

TYPE XVIII. Neurological assessment--complete

In this category the nursing assessment tool of a complete examination of the neurological system adapted to the unconscious patient was done for the purpose of:

a. identifying behavioral progression toward or regression from recovery of consciousness;

b. providing external stimuli and sensory input to stimulate arousal.
TYPE XIX. Neuro assessment routine with tape

In this category the nursing therapy included the assessment of vital and neuro signs performed by nursing personnel manually and not monitored by equipment and was followed by one 15-minute orientation tape.

TYPE XX. Direct nursing care given solely for the purposes of orienting the patient

In this category the nursing therapy included nursing care given by the research staff to incorporate several types of orienting stimuli simultaneously, including turning while preventing head/neck flexion, extension, rotation (Mitchell; Mauss; Lipe; Ozuna, 1980; Shalit; Umansky, 1977).

TYPES XXI to XXX.

In this category individualized tapes were included which met special patient needs. These were made and played for the patient.

Recovery Criteria

The following were used to identify recovery, using time of admission as the starting point. Days/hours until:

- Coherent verbal communication
- Successful use of translator for patients unable to speak
- First purposeful voluntary movement of an extremity
- First attempt to swallow food or drink
- First attempt to eat or drink by self
- Eating/drinking with some assistance (e.g., opening cartons, cutting food)
- Eating/drinking without assistance
- First attempts to dress self
- Able to dress self completely
- First attempts to groom self
Self grooming

Score on Glasgow Coma Scale increases even though a decrease in score occurs later within 24 hours.

Score on Glasgow Coma Scale increases with no decrease in the following 24-hour period.

Score on Glasgow Coma Scale reaches 15 but decreases later within 24 hours.

Score on Glasgow Coma Scale reaches 15 with no decrease in the following 24-hour period.

First response to command
Consistent response to command
First attempt to communicate
First verbal communication attempt
First successful communication attempt
Disappearance of post traumatic amnesia
Out of bed in chair
Placed on tilt table
First attempt to ambulate (Elwell; Ross, 1980).
First medical order for visit to physical therapy outside patient unit.

Days of hospitalization
Days and months at extended care facility if discharged to one
within a one-hour drive from Loma Linda (Muderspach; Swanson, 1980).
Methodological Assumptions

In conducting this portion of the study, a type of pilot study, certain factors were generally accepted as true. However, the investigators were aware that several of the assumptions might in fact be untrue because of the lack of evidence in existence pertaining to the assumed truths. Therefore, the following assumptions, made for the purposes of this pilot study only, were that:

1. The unipolar and bipolar scalp electrodes accurately reflected the electrical activity of the cerebral cortex as recorded by the EEG.

2. The portable Beckmann EEG was accurately calibrated and that the record it produced accurately reflected the electrical activity of the cerebral cortex.

3. A 3-montage clinical EEG made with the portable Beckmann EEG Polygraph was sufficient to reflect day-to-day progress.

4. No specific signs of arousal were eliminated by the montages chosen (A,B,C).

5. The Glasgow Coma Scale was a reliable and valid tool for measuring levels of arousal in coma.

6. The scores produced by the Glasgow Coma Scale were accurate as computed by each observer.

7. Family/friends of the comatose patient honestly and accurately identified, simulated or produced elements of the patient's past which were of meaningful significance to the patient.
8. The patient's memory was intact prior to coma onset.

9. The patient's intellect, cognitive and physical abilities were within normal limits prior to coma onset.

10. The patient, if conscious, would choose to live if given that choice. That is, it was assumed that the life forces which struggle for survival were working in the patient's favor and that no life event or circumstance had depressed or affected the patient so that he had given up the will to live.

**Organization of the Remainder of the Study**

An introduction and background for the study were provided in Chapter 1. Both a critical review of the literature as well as a descriptive review dealing specifically with nursing literature are included in Chapter 2. The methodology and data collection of the study are detailed in Chapter 3. Results and observations are presented in Chapter 4, while the conclusions, recommendations and implications for nursing are in Chapter 5.
Chapter 2

REVIEW OF THE LITERATURE

The literature available on coma has reached massive proportions. Literature reviewed for this project represented a small selected portion of that available on the total subject and in the specific categories addressed. The categories addressed were: (1) factors affecting coma or its assessment post onset; (2) treatment of coma; (3) the EEG in coma; (4) prognosis of the comatose patient; (5) states resembling sleep/waking in comatose and normal adults and adolescents; and (6) nursing care of the comatose patient.

Factors Affecting Coma or Its Assessment Post Onset

In a prospective descriptive study, Cold evaluated the cerebral metabolic rate of oxygen in 22 comatose patients in relationship to clinical outcome six months to two years after onset of coma. Results indicated a "high jugular venous oxygen tension and, in some studies, very low oxygen consumption. A critical, low CMRO₂ was not found, and values of about 0.4 ml/100g/min were compatible with restitution of intellectual function." (Cold, 1979, p. 249) There was no significant relationship between CMRO₂ and either clinical outcome or time after the trauma. Of the ventricular fluid parameters, a significant correlation was found between ventricular fluid lactate and CMRO₂. In patients who recovered, a significant correlation was found between IVP and CMRO₂ and also between Pa₇/co₂ and CMRO₂.
Another prospective descriptive study of 86 severely head-injured adults was undertaken by Frost, Arancibia and Shulman. The purpose of the study was to assess the effect of early hypoxemia on outcome in head-injured patients as well as attempt to differentiate between peripheral and central causes of respiratory insufficiency. A third purpose was to qualify the effect, if any, of a changing ventilatory pattern on initial pulmonary dysfunction. Results indicated that the existence of pulmonary shunt was a prognostic indicator of outcome in head-injured patients. "Correlation with GCS values appears to be close enough to warrant consideration of shunt calculations in assessment of outcome in intracranial trauma." (1979, p. 771)

In the majority of cases, respiratory dysfunction appeared to occur at the time of injury and to be due to neurogenic causes. Patients over 50 years of age with an initial shunt above 15 percent did not survive. Even intensive respiratory care could not prevent death in patients with severe head injury and a large pulmonary shunt. However, maximum supportive care did improve the prognosis considerably even in the event of profound coma if initial pulmonary shunting was small. Expressed in percentages, in 39 patients who improved, mean pulmonary shunt was 8.9 percent; in 12 patients who survived with deficit, mean pulmonary shunt was 13.6 percent; in 35 patients who died, the mean initial shunt was 15.5 percent.

Evaluation of the scientific accuracy of this study was difficult due to the lack of information provided in the written report. Sample selection included all head-injured adults who underwent emergency surgery, excluding only those who had a history of chronic lung disease.
With this almost unlimited age span (15 to 85 years), results should be
generalizable only to the sample because of the tremendous variations
that 70 years can make in pulmonary capacity, especially without any
recorded baseline capacity before injury for comparison. Furthermore,
there were no recorded variables specific to pre-accident life style
such as smoking habits, exercise habits, etc. Although the Glasgow
Coma Scale and the American Society of Anesthesiologists at risk
classification were accepted as respected instruments by health care
professionals several years ago, no mention was made of their validity
or reliability. While most results were given in the form of per-
centages, mention was made in one case that the statistical analysis
showed a significant difference. Although the p value was given at
0.01, there was no indication of which statistical test or procedure
was used to calculate the results. Without further information the
study could not be replicated. Author bias was not apparent in this
report of the study.

Clifton and others (1980) used a prospective, descriptive method
of studying the course of 124 patients with closed head injury to
determine the influence of the "rate of change of neurological signs
on the likelihood of deterioration, and to determine the influence of
the intracranial pathology . . . on the neurological course of the
patient." (Clifton, and Others, 1980, pp. 611-612) Results indicated
that whereas the time of death occurred either within 48 hours or after
seven days or more after injury, neurological deterioration was most
likely to occur on days 2 to 7 after injury. Patients with hematomas
were three times more likely to deteriorate than those with diffuse
brain injury. Computerized tomograph scans of those 24 patients who were deteriorating could be divided into four categories:

1) those without new mass effect (8 cases); 2) those with new or increased hemispheric edema (6 cases); 3) those with generalized edema (2 cases); and 4) those with focal or lobar areas of new edema or hemorrhage (8 cases).

(Risk factors for late deterioration were "failure to improve rapidly and the presence of a hematoma producing mass effect." (1980, p. 622)

In contrast, a prospective experimental study was conducted by Enevoldsen and Jensen to examine regional cerebral blood flow, cerebral intraventricular pressure, systemic arterial blood pressure and cerebral ventricular fluid in 23 patients during the acute phase of severe brain injury. Angiotensin infusion was used to test cerebrovascular autoregulation and passive hyperventilation was used to test $CO_2$ response. Intraventricular pressure was measured continuously and kept below 45 mm Hg in all patients during the study.

Results revealed a common phenomenon: dissociation between cerebrovascular autoregulation and $CO_2$ response. "Typically, autoregulation appeared preserved in the most severely injured areas of the cerebral cortex when the patient was deeply comatose, but deteriorated concomitantly with recovery; by the time the patient became alert, the autoregulation was always impaired. The $CO_2$ response was impaired only in patients who were deeply comatose and had attacks of decerebrate rigidity; during recovery the $CO_2$ response became normal." (1979, p. 689) The authors concluded that severe brain damage would be suggested by preserved autoregulation associated with impaired $CO_2$
response; moderate or severe brain damage in recovery would be suggested by impaired autoregulation associated with preserved CO$_2$ response.

Accurate evaluation of the scientific accuracy of this study was difficult due to the fact that the clinical material and methods were described in a previous paper which was not located and were only briefly outlined in the present report. The only criteria for sample selection was that the patient had sustained head trauma and was deeply comatose on admission. No mention was made of screening patients for previous mental or physical conditions. Reliability and validity of the two tests used (angiotensin infusion and passive hyperventilation) were not discussed although references were given. Because of the number of uncontrolled and unrecorded variables, the results of the study would be generalizable only to the sample studied. The study was not replicable with only the reported information. It seemed doubtful if the bias of the authors affected the outcome of the study; however, the lack of a control group lessens its scientific credibility.

Similarly, cerebral oxygen extraction, cerebral blood flow and cerebral metabolic rate were studied in 25 patients who were comatose after having been successfully resuscitated from cardiac arrest. Results showed no changes in arterial Pco$_2$ and arterial oxygen saturation was near 100 percent. Meanwhile, "jugular venous PO$_2$ and oxygen saturation rose so that the a-jv oxygen content difference fell progressively over the period of measurement. This [was] indicative of a progressive increase in the ratio of CBF to metabolism." (Becksted, and Others, 1978, p. 570) Results also showed that from "2 to 6 hours after cardiac resuscitation both CBF and CMRO$_2$ were severely and proportionately
reduced to less than 50 percent of normal. . . . After 6 hours CBF was increased disproportionately to CMRO₂ so that a relative hyperemia developed and persisted for the duration of the study." (1978, p. 570) The authors concluded that while regional ischemia and inhomogeneity of flow could not be ruled out, the study did contribute negative evidence for global cerebral ischemia between two and 60 hours post-resuscitation contributing to failure of recovery.

A detailed account was provided in the report describing the sample and the method of data collection. While reliability and validity were not discussed in the article, references were given for one of the methods used in the study. Since the data were interval data, analysis of variance was appropriately applied. Replicability could be achieved within the parameters outlined in the study. Results of the study would be generalizable to the population of which this sample formed a part since the criteria for sample selection ruled out only patients who exhibited no evidence of recovery of brain function (iso-electric EEG and absent cranial nerve reflexes) or patients who rapidly recovered consciousness post resuscitation. However, results were not interpreted in the light of any potential CBF-reducing therapies such as suctioning. Adherence to the scientific method was apparent in the report of the study reviewed.

In comparison, a prospective, quasi-experimental study which included 21 patients in coma following severe head injury was carried out to assess the value of blink reflexes in evaluating brainstem function. Results indicated that absence of all blink reflexes correlated with clinical signs of anatomical or functional disorder of the
medullary of pontine-medullary region. The presence of the early component of the blink reflex (R1) "shows the integrity of at least a part of the pontine structures. The appearance of the late R2 component [was] correlated with a better chance of recovery from coma." (Bounabuidi; Rossi; Starucci; Ravelli, 1979, p. 470). A correlation was also established between blink reflexes and the evaluation of stage of coma as determined by the Glasgow Coma Scale.

The generalizability of the results of the study was limited because of the small sample size (21) and the wide range of subjects' ages (3-60). A control group was absent. The method of obtaining informed consent was not mentioned in the article, a factor which would be considered of paramount interest since the patients were recipients of an electrical stimulus. Replicability of the study would require more complete information about the method of data collection. While the authors concluded that their results upheld a correlation between stages of coma established by blink reflexes, Glasgow Coma Scale scores and the anatomicoclinical method defined by Plum and Posner (1972) there was no evidence that statistical analysis was done to support that conclusion.

**Treatment of Coma**

A prospective, experimental study was done to test the effectiveness of thiopental protection from cerebral anoxia after cardiopulmonary arrest. Twenty-three adult dogs were sedated, curarized and then asphyxiated. Seven minutes after electrocortical silence, CPR was started. "Five minutes after resumption of spontaneous circulation . . . the dogs
were treated either with high- or low-dose thiopental sodium, or not given treatment at all and used as controls." (Snyder; Ramirez-Lassepas; Sukhum; Fryd; Ho Sung, 1979, p. 136) Results showed that 16 percent of the controls and 14 percent of the experimental animals had normal outcomes. All others were uniformly severely damaged. "Except for one dog in the low-dose group that recovered neurologically, thiopental-treated dogs showed no neurological or survival improvement over the controls." (1979, p. 135)

In spite of some weaknesses, the overall design of the study was good. Although the animals were classified as "adults" based on dentition, the authors still maintained that the "variability in resistance to anoxia . . . may be due to the age spread among the animals." (1979, p. 138) The variables introduced as a result of using mongrel dogs whose past health status had not been reported, the small sample size, and the difficulty in applying results from an animal study to humans limits the generalizability of the findings. One might also question the ethics of permitting dogs to suffer uniformly severe damage even though they recovered some function.

Breivik and others performed a prospective quasi-experimental study with 40 patients to determine clinical feasibility of barbiturate therapy after cardiac arrest. Patients included in the study suffered severe ischemic-anoxic insult of five minutes or longer, or were comatose as a result of the insult. Results indicated that 22 of the 40 patients had arrest times of over five minutes, which should only yield a complete neurological recovery in fewer than 10 percent of the cases using traditional therapy. In this study, by using barbiturate loading, 14 of the
22 patients (64 percent) achieved a complete neurological recovery. "For all 40 cases combined, 24 (60%) recovered consciousness, 3 (7%) had persistent vegetative state, 6 (15%) survived with deficits, and 10 (25%) developed brain death." (Breivik; Safar; Sands; Fabritius; Lind; Lust; Mullie; Orr; Renck; Snyder, 1978, p. 241)

The results of this study were diluted by two obvious factors. First, there was no indication as to how the sample selection was made. This would seem particularly critical in light of the fact that three hospitals, separated by great geographical distances, participated in the study. Secondly, as admitted by the authors themselves, there was no control group with which to compare the study results.

In contrast, Cooper and others included 76 patients in a prospective double-blind study of the effects of dexamethasone administration on the outcome of patients with severe head injuries. Patients were classified according to the Grady Coma Scale and the Glasgow Coma Scale. Patients were assigned to one of three groups on the basis of a random allocation schedule. The groups received treatment according to either "low dose" dexamethasone, "high dose" dexamethasone, or placebo. Patient outcome was assessed at six months according to the criteria of Jennett and Bond, or at the time of death. Results indicated that "the proportion of patients with 'good' outcomes did not differ significantly among the three treatment groups. Patients on the high-dose regimen did slightly worse than patients on the low-dose regimen or placebo, but the difference was not statistically significant." (1979, p. 307) The results could not demonstrate that dexamethasone had a significant effect on intracranial pressure patterns or serial neurologic examinations.
"Good outcome was associated with age under 10 years, lighter depth of coma on admission and the preservation of brain-stem reflexes upon admission." (1979, p. 307)

The study was weakened by the fact that the authors made a change in design in order to accommodate statistical analysis. While they were recorded, the specific outcome categories according to Jennett and Bond were lumped together into "good" or "bad" results in order to have greater numbers of patients in each category. Thus, the statistics reported in the study do not reflect the same degree of scientific specificity as had originally been designed.

Sample selection in this study was all-inclusive. All patients with severe head injury were accepted into the study. While most variables were recorded, one wonders if the study would not have been strengthened by controlling for some of the variables, such as extent of other life-threatening injuries, or previous medical history.

The EEG in Coma

Obeso, Iragui, Marti-Masso, Maravi, Teijeira, Correra, and Teijeira (1980) recorded EEG, somatosensory evoked potentials, blink reflexes and H wave reflexes in three patients who were in alpha coma secondary to cardiac arrest (in two patients) and brainstem infarction (one patient). The EEGs in all three patients showed no reactivity to external stimulation and "alpha waves were diffused over the frontal regions." (1980, p. 65) Results from the somatosensory evoked potentials, blink reflexes and H wave reflexes were "compatible with damage to the brainstem reticular formation with sparing of thalamo-cortical
circuits." (1980, p. 63) The report concluded that "alpha coma should be only considered as a dissociation between consciousness and the EEG, because both phenomena are partially independent. Detailed neuro-physiological studies along with clinical data may be useful in the evolution of patients with alpha pattern coma, overcoming the absolute limitation of EEG recording." (1980, p. 66)

The report was presented as a descriptive series of case studies. While the method of data collection was described in some detail, there were no criteria given in this report relative to selection of the sample nor for obtaining informed consent. Reliability and validity were not discussed. Generalizability was limited because of the small sample size. The lack of information in this report would hinder replicability since the method section failed to mention specific time frames for patient stimulation. Even after noting that this report lacked certain detailed information, the scientific approach of the authors was fairly obvious.

Similarly, in a study of 30 patients who were comatose as a result of cerebral anoxia following cardiac arrest, Alving, Moller, Sindrup and Nielson (1979) recorded at least one EEG with activity in the alpha range (1979, p. 100). The alpha activity was often diffusely distributed, sometimes being more pronounced occipitally. The study supported the hypothesis that "alpha activity in comatose patients is an extremely poor prognostic sign." (Alving, and Others, 1979, p. 99) Only one of the 30 patients survived, and he with considerable neuropsychological deficits (1979, p. 100). Four patients showed improved
level of consciousness but three of them died as a result of cerebral anoxia without reaching a level of cortical function (Alving, and Others, 1979, p. 100).

A single case study published by Moller (1978, pp. 518-522) described a 39-year-old man who also survived alpha pattern coma following cardiac arrest. Six months after onset of coma the patient displayed signs of dementia and disorientation to time. Despite these limitations, he was fairly independent in self-care. The patient was still alive six years after onset of coma.

Using a descriptive approach, Rumpl, Lorenzi, Hackl, Gerstenbrand, and Hengl (1979) presented the results of 130 EEGs analyzed from 113 patients with acute secondary traumatic midbrain and bulbar brain syndromes. Patients were classified neurologically in six stages according to Gerstenbrand and Lucking. Results indicated that "the EEG pattern was related to the stage of the midbrain syndrome caused by supratentorial brain shift. A decrease in the number of different EEG patterns was associated with increasing intracranial pressure." (1979, p. 495) They also noted that the disappearance of sleep or sleep-like activities indicated an unfavorable prognosis. Similarly, alternating pattern and loss of reactivity were associated with unfavorable prognosis. "Lateralization by the EEG proved to be superior to clinical findings in full stages of the midbrain syndrome." (1979, p. 495) When herniation occurred, the EEG regularities noted above were blurred by circulatory, respiratory and metabolic encephalopathies.

Considering the results of this study in further detail it was
of interest that the following observations were made. Three of the 21 EEGs done on patients in the category acute traumatic midbrain syndrome-stage 1 "could not be differentiated from physiological sleep phases I-III by conventional visual evaluation," (1979, p. 489) and four of 36 records of patients in stage 2 showed a normal-looking sleep pattern. "Sleep and sleep-like potentials, confined to one hemisphere, appeared in nine tracings, accompanied by contralateral predominant slowing in eight cases." (Rumpf, 1979, p. 490) Five of 36 records of patients in stage 3 showed asymmetrical sleep or sleep-like potentials. "Atypical sleep pattern was seen in two out of five patients dying of brain death." (1979, p. 491)

The nature of this study involved a fairly all-inclusive sample which was representative of the patient population at large. Reliability and validity were not discussed, and were particularly questionable in the light of standardized methods of electrode placement, the use of which was not mentioned in this study. Results were not subjected to statistical analysis, but were reported as categorized whole numbers. Although the original sample size was large (113), the subclassification of patients into six categories reduced the generalizability to patients categorized similarly. Replicability of the study would depend on further description of the methods of data collection, personnel involved in recording and interpreting EEGs, and variables to be recorded. In the present report specific bias on the part of the authors was not detectable.

A prospective descriptive study was done at the Hospital for Sick Children in London comparing EEG features with clinical outcomes
in 636 patients, 406 of whom had sustained complete cardiocirculatory arrest and 230 of whom had cardiopulmonary difficulties. Results indicated that prognosis and probable quality of survival after resuscitation was primarily based on the evolution of early EEG findings. During the first week after resuscitation, improving EEG features were in keeping with a much more favorable prognosis than persistent irregular slow wave activity. EEG activity by the end of the first month gave a clearer idea of the probable subsequent clinical evolution. "Among the patients who survived more than two weeks, severe neurologic sequelae were present in half of the children with persisting irregular, very slow activity in the EEGs. In contrast, of a total of 121 survivors with rapidly-improving EEGs over the first few days, only six had residual severe neurologic sequelae." (Pampiglione; Chaloner; Harden; O'Brian, 1978, p. 286) After the end of the first month, the contributions of the EEG investigations were much more limited while the general clinical features were usually much more clear.

Completeness of detail was lacking in this report of the study, although the author made an attempt to salvage the credibility of the sample selection and method of data collection by referring the reader to some of his previously published articles. In the method section it was stated that at the time the EEG was done, various "biochemical evaluations" were also noted (including heart rate, respirations, blood pressure changes, etc.). Not only was that the last mention of these clinical indices, but there was no explanation regarding how these factors had been grouped together to formulate the "clinical picture" which was eventually correlated with EEG findings.
There was an apparent lack of control over the variables of this study. There was no explanation given for including two types of patient groups in the sample: differentiation between the EEG outcome of patients in the "circulatory arrest" group versus those with "severe cardiorespiratory difficulties" was not made. Recording for the other variables such as sex and pre-existing metabolic imbalances, particularly pre-existing cerebral involvement, was not evident in this report.

Prognosis of the Comatose Patient

Sorenson, Tomassen and Wernberg (1978) compared the prognoses of 65 patients who remained in coma more than 24 hours after cardiac arrest (1978, pp. 840-842). The 13 patients whose EEGs showed predominant alpha activity had a longer period of survival and a higher incidence of recovery of consciousness than the 52 patients whose EEGs showed other rhythms. The former group also demonstrated less severe neurological sequelae, and its survivors, in spite of memory deficits, were able to manage at home. All survivors of the latter group remained hospitalized.

Similarly, Rimel, Jane and Edlich reported on a prospective descriptive study involving 406 patients who required neurosurgical services. Each patient was given a score by a neurosurgeon, a nurse and an EMT using the Glasgow Coma Scale. At discharge, patients were evaluated as being in one of three groups: dead, self-sufficient, or dependent. Results indicated that on admission 70 percent of patients had a GCS between 13 and 14, 18 percent between 5 and 8, and 7 percent at 4 or less. In relating the GCS with outcome, it was found that the
lower the GCS (4 or less) the higher the mortality (45 percent). Conversely, the higher the GCS (9 to 12), the lower the death rate (3 percent). "There was a high rate of dependency in patients with a GCS between 9 and 12 (46%) and 55% in patients with a GCS between 5 and 8." (1979, p. 66) There was a trend that identified patients with lower GCS scores as having traumatic involvement of other systems besides the neurological injury. Variation among health care professionals in assessing GCS appeared to be less when the patient's score was in the higher bracket (9 to 15).

The report of the study contained limited information about the method of data collection, particularly in reference to time frames for patient assessment. The absence of a pre-set alpha and of a procedure for statistical analysis reduced the weight of the results.

A prospective descriptive study was done to evaluate 63 patients with global ischemic cerebral injury who survived cardio-pulmonary arrest. Patients were initially classified according to the levels of consciousness devised by Plum and Posner. Patient evaluation continued at intervals during the hospital stay and at six months. The results indicated that of the 25 survivors, 16 made an excellent recovery, eight made a good recovery, and one a poor recovery. Only patients who achieved full alertness survived. "Some patients improved from all depths of initial coma to full alertness, but the longer coma persisted the less likely this became; there was a clear relationship between initial depth of coma and likelihood of arousal." (Snyder, Loewenson, Gumnit, and Others, 1980, pp. 54, 56) A strong correlation was observed between the level of consciousness on day two and survival.
Sample selection for this study consisted of patients admitted consecutively following cardio-pulmonary arrest. Excellent screening criteria were included in the report. The method of data collection was detailed, including the types of personnel involved in patient evaluation. The method of obtaining informed consent was not included. Reliability was alluded to as a by-product of preliminary sessions. The conclusions were supported by statistical analysis. Most of the results were presented as whole numbers or percentages. In two cases, however, Chi square was used appropriately in comparing interval data. The study would be generalizable beyond the sample studied within the parameters of the described population. The study as reported in this article was replicable, with the exception of obtaining informed consent. From the amount of information presented in this article it seemed that the authors did adhere to the scientific method.

In addition, a retrospective, descriptive study was done by Cane and Buchanan to correlate immediate post-resuscitation status following cardiac arrest and clinical outcome in 74 ICU patients. The criteria used to describe post resuscitation status included acid-base status, pupil size and reactivity, coma, body temperature, and return of spontaneous respiration. Results indicated that survival was most common with the acid-base balance within normal limits. However, if there was to be an imbalance, acidic patients had a better outcome than those with alkalosis. "Hypothermia, coma, dilated pupils and apnea all heralded a poor prognosis." (1978, p. 595) Of the 19 patients (25.6 percent) who were ultimately discharged from the hospital, only 14 (18.9 percent) were neurologically normal. Neonates showed the best
response to resuscitative efforts, with the pediatric age group being second best. Those patients who were resuscitated rapidly at night had the best chance of retaining an intact neurological system. "Of the 55 patients in the series who died, 24 (43.6%) died within 24 hours and a further 25 (45.4%) died within one week of admission. The remaining deaths occurred within 10 days of the initial cardiac arrest." (1978, p. 595)

While this report of Cane and Buchanan's study (1978) contained many interesting conclusions, there was very little information regarding the method of data collection and the method of statistical analysis to support those observations. The authors suggested that there is "little indication" to admit post resuscitation patients to the ICU because of their high mortality compared to other ICU patients. Such a statement which carries intense ethical and moral overtones was far beyond the scope of the results of this study.

Erhardt, Sederholm and Gertz included 319 patients in a comparative descriptive study of prognostic indicators in cardiac arrest situations where resuscitation was commenced in the emergency room less than 15 minutes after arrest. Results indicated that of the 319 patients on whom CPR was performed, 269 died and were not studied any further. The study showed that about 4 percent of all cardiac arrest patients admitted to the emergency room were long-term survivors. "To improve prognostication in patients with initially successful resuscitation, Bayes' theorem was applied using four clinical findings after 24 hours of treatment: reactions to painful stimuli, pupillary size, light
reactions, and blood pressure. Bayes' theorem as well as coma depth after 24 hours gave valuable information regarding individual prognosis." (Erhardt; Sederholm; Gertz, 1979, p. 55)

The study may have had merit in that it showed some prognostic tools that could be used to avoid unnecessary intensive care treatments. However, many more studies of this nature would be needed to insure validity and corroborate the findings. Can theory ever predict outcome in humans well enough to govern care?

In a retrospective study, Bricoli, Turazzi and Feriotti examined the incidence of prolonged post-traumatic coma, time course of recovery and ultimate outcome and "the possibility of predicting the protraction of unconsciousness from early stage symptoms and signs." (1980, p. 626) The sample consisted of 135 head-injured patients who were still unresponsive two weeks after the onset of coma. Results from this study indicated that 4 percent of patients with acute traumatic coma and 0.6 percent of all patients admitted with head injury sustained prolonged unconsciousness. The patients with prolonged coma were compared to a population of 800 consecutive patients with traumatic coma. Those with prolonged coma were shown to have (1) a younger mean age, (2) a higher incidence of associated extracranial lesions, and (3) a higher incidence of mesencephalic and diencephalic syndromes and signs of brainstem involvement.

The same investigators studied sleep also, but only from a behavioral point of view. "After the eye-opening phase, most patients sleep almost continuously for a while; then the period of sleep begins to shrink, ... normal sleep-awake rhythm of the nycterohemeral type."
(Bricoli; Turazzi; Feriotti, 1980, p. 628) In this series of 135 patients, by the end of the first month, 40 patients were predominantly asleep; by the end of the third month, 21 patients were predominantly asleep, and by the end of six months, only six patients continued to sleep. "Restoration of an observable sleep-awake rhythm increased accordingly." (1980, p. 628) In the progression of returning neurologic function, 52 percent of patients executed simple commands in the first three months; 13 percent did so after the third month, and only 1.5 percent after the sixth month. Speech restoration occurred mostly between the third and sixth months (16 percent), with 51 percent of the patients eventually regaining the capacity to communicate verbally. "The distribution of mortality over time indicated that after six months the patients' general and neurological condition will stabilize; there will be only sporadic deaths." (1980, p. 629) The outcome of the 95 survivors showed that 44 percent had a satisfactory recovery or provided self care, 44 percent were severely disabled, and 12 percent were vegetative.

The numerous comparisons and the conclusions stated were weakened by the fact that the report of the study did not indicate to what statistical analysis the data were subjected. The criteria for sample selection were amazingly broad, leaving the numerous variables such as previous medical history, extent of trauma to other bodily parts, etc., unrecorded, much less controlled.

In comparison with the previous studies reported in this section, Rhoades and Garland designed a retrospective, descriptive study to review the functional levels of 121 patients who had sustained closed head
injury at least two years earlier, and to relate these to factors in their actual injury phase which might have indicated recovery potential. The results of the study revealed that the factors which are of prognostic value are age, coma duration and presence of decerebration. "In the youngest age group less satisfactory recovery is seen with the longer periods of coma." (Rhoades; Garland, 1978, p. 106) For patients who recovered from coma during the first week, 69 percent made a good recovery, during the second week, 70 percent, during the third week, 39 percent, and during the fourth week, 17 percent. There were no patients who made a good recovery when in a coma longer than four weeks. Decerebration was seen as a poor prognostic sign, particularly with increasing age.

The major weakness of the study was the absence of statistics to support certain conclusions. The sample was taken from patients who were referred to a major rehabilitation center. As such, it was expected that patients could come from a variety of backgrounds--from isolated community hospitals to sophisticated medical centers. Thus it was difficult to believe the statement, "In this series there was no significant difference in treatment methods to enable comparison." (Rhoades; Garland, 1978, p. 109) There were no data to help the reader understand how the authors arrived at this conclusion, as well as others equally hard to believe.

Thomassen and Wernberg retrospectively studied the outcome of 181 patients who were resuscitated from cardiac arrest. Results of the study showed that permanent brain damage was rare when coma lasted less than six hours. No patients with coma lasting more than 24 hours
survived without permanent brain damage and the longer the duration of
the coma, the greater the severity of brain damage. "None of the
patients who were in coma for more than seven days ever regained con-
sciousness." (1979, p. 147) Older patients (over 60 years) were more
sensitive to brain damage than younger patients. The design of the
study was retrospective in nature, creating a total reliance on the
written documentation of others for the data. The results could there-
by have been clouded by the omissions or inconsistencies of previous
multiple observers. Sample selection was incompletely described,
leaving many variables unrecorded and uncontrolled. Statistical anal-
ysis (which was not used in this study) would have strengthened the
conclusions.

Utilizing a different approach, Seales, Rossiter and Weinstein
evaluated the neurologic application of the brainstem auditory evoked
response (BAER) as an aid in the early diagnosis and prognosis of 17
patients who were comatose as a result of blunt head trauma. Testing
was accomplished by presenting clicks at a rate of 10 per second and at
a loudness of 60dBSL. The brain's electrical activity was amplified
500,000 times and was recorded from gold cup electrodes attached at
the vertex (Cz) and ipsilateral mastoid (1979, p. 38). Results indi-
cated that initial BAERs can be abnormal as a result of transient
reversible dysfunction of the brainstem auditory pathway. However,
after the early critical period (3 to 6 days postinjury), the BAER
status served as a significant prognostic aid by correlating with
patient outcome "at a time when critical prognoses were often uncertain."
(Seales, Rossiter, Weinstein, 1979, p. 347) Despite its limitation of
having a small sample size, the report of the study was refreshingly detailed. Questions regarding the thoroughness of the investigative procedure were allayed by the inclusion of three detailed illustrative case reports. While the authors attempted to answer some questions by performing this investigation, they were also quick to point out that much research was needed before BAERs will be understood well enough to become a reliable diagnostic tool.

In addition, using a descriptive quasi-experimental method the EEGs and outcomes of 55 patients who demonstrated abnormal slow wave arousal in response to auditory (tapping or calling), tactile (light touch) and painful stimuli were studied. Prolonged episodes of delta activity occurred with states ranging from drowsiness to deep coma but never in alert patients. It was evident during a number of clinical conditions, most commonly following head injury. The stimulus-related slow wave response lasted for a minimum of six and a maximum of 34 days. Two- and ten-month follow-ups found over half the patients experiencing a favorable outcome, being either clinically normal or having minor neurological deficits (Schwartz; Scott, 1978, pp. 300-304).

While the written report contained a broad but adequate description for choosing the experimental subjects, there was no mention of a control group. The overall design of the study was not presented clearly. Time frames for data collection were omitted, although some time-intervals have been recorded. While the type of electrode placement was named in this report there was no mention of its reliability nor of the qualifications of the persons performing or interpreting the EEGs. Statistical analysis was not used in this report. Results were given
in percentages or whole numbers. Generalizability of the findings was limited since there was no control group with which to compare results. Replicability could not be accomplished without more information from the original proposal. Although the original study may have been very well done, the limited amount of information in the present report would cloud any judgment relative to the scientific approach of the authors.

**States Resembling Sleep/Waking in Comatose and Normal Adults and Adolescents**

The overall study included the use of continuous recordings of the EEGs, electromyograms (EMGs), and electro-oculograms (EOGs). As previously noted, the presence of sleep-like states or cycles was a favorable prognostic sign. In addition to studies already cited which contained information on sleep, three other studies were pertinent.

The EEGs of 13 patients in alpha coma were reviewed by Westmoreland, Klass, Sharbrough, and Reagan (1975, pp. 713-718). One patient whose EEG was monitored continuously for 16 hours showed "spontaneous cyclic sleep patterns during the night . . . consisting of alternating episodes (lasting 15 to 45 minutes) resembling stages 2 and 3 of sleep with spindle activity and diffuse delta activity suggestive of stage 4 sleep." (1975, pp. 714, 715) Evidence of rapid eye movement sleep was absent, however, and after five hours the patient remained clinically unchanged as the EEG reverted to the previous alpha pattern.

However, the location of the injury may produce sleep-like states as demonstrated in the following report. A prospective experimental study using 12 adult cats was conducted by Shouse and Sterman (1979) to "clarify the relationship between sleep spindles and seizure
thresholds by examining the effects of lesions in ventrobasal thalamus and dentate nucleus on both of these variables." (1979, p. 2) Results indicated that those animals with dentate or ventrobasal lesions: (1) had significantly elevated seizure latencies than did the controls; (2) tended to sleep more and be awake less; (3) displayed significantly more SWS than did control animals after the lesion; (4) displayed significant increases in SWS relative to their own prelesion EEG baselines. "Furthermore, an increased incidence of sleep spindles was associated with dentate lesions while animals with ventrobasal thalamic lesions showed a shift in frequency from 8-11 c/sec to 12-15 c/sec activity during that state." (1979, p. 10) The authors suggested that these results supported the concept that sleep spindles did not enhance seizure activation and may have actually exerted a protective influence.

Furthermore, the absence of REM sleep noted in comatose patients may be more of a problem to younger patients. In a double-blind experiment, Glaubman and others (1979, pp. 252-254) studied the relationship between the "defensive strain" and REM need in adolescents as indicated by resistance to REM deprivation. Their sample consisted of 10 adolescents aged 16 and 17, and 12 young adults aged 25 to 27. Subjects filled out a sleep questionnaire, the Fitts Self-Concept Scale and an abbreviated Thematic Appreciation Test. In the laboratory, methodology involved waking each subject whenever he entered a REM stage of sleep and keeping him awake for at least three minutes. Conclusions from the Glaubman study were limited by the small sample size. Results showed that the adolescent group experienced (1) a shorter REM latency, (2) a slightly longer REM than the adult group, and (3) significantly more
awakenings than the adult group. The authors were unable to find a way "to transform the general psychological evaluations into a 'defensive strain' scale," thus making it impossible to "correlate the number of awakenings of each subject with his defensive strain." (1979, p. 252)

**Nursing Care of the Comatose Patient**

The review of nursing literature was a cooperative effort for the entire study. Most of the credit for the compilation belonged to Annette Ross, M.S., and was included here because it was part of the conceptual rationale of the study and because nursing actions and implications were based upon it.

The review of nursing literature was limited to basic texts published since 1970. The results of the review were presented in tabular form for clarity and brevity. The table was organized from earliest to most recent publications. Publications in the same year were listed alphabetically.

Eight major factors were considered in the literature review. They included etiology of coma, physical and preventive care, psychological care, arousal regimen, reference to sleep-wakefulness cycles, the discussion of long-term care, levels of consciousness and prognosis of EEG stages. The subject of environmental enrichment was ignored in most textbooks in nursing although many cautioned that the patient might hear (without documentation) and that nurses should communicate with the patient. The subject of an arousal regimen was also most noticeable by its absence.
<table>
<thead>
<tr>
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<th>Levels of Consciousness</th>
<th>Prognosis of EEG Stages</th>
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</thead>
<tbody>
<tr>
<td>Kintzel (1971)</td>
<td>General</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>None</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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<td></td>
<td>with specifics</td>
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<tr>
<td>Smith, Germain, Gips (1971)</td>
<td>General</td>
<td>Yes</td>
<td></td>
<td></td>
<td>No</td>
<td>No</td>
<td>Some</td>
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<tr>
<td>Mathoney, Nolan, Hogan, Griffin (1972)</td>
<td>General</td>
<td>Yes</td>
<td></td>
<td>None</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<tr>
<td>Barber, Stokes, Billings (1973)</td>
<td>Somewhat, mostly general</td>
<td>Yes</td>
<td></td>
<td>No</td>
<td>No</td>
<td>Some</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>Hinkhouse (1973)</td>
<td>Related to cranio-cerebral trauma</td>
<td>Yes</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<tr>
<td>Hudak, Gallo Lohr (1973)</td>
<td>General, specifics mentioned</td>
<td>Some</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>Luckman &amp; Sorensen (1974)</td>
<td>General</td>
<td>Yes</td>
<td>Explains frequent testing to both patient and family (p. 340).</td>
<td>Reorientation as patient regains consciousness.</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Swift (1974)</td>
<td>Related to head injury</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Deland, Passos (1975)</td>
<td>General with specifics</td>
<td>Yes</td>
<td>Precede all procedures with quiet, concise description. Physical environment kept free of disturbing stimuli (p. 264).</td>
<td>No</td>
<td>HIS sleeping patterns are disturbed.</td>
<td>Some</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Brunner, Siddarth (1975)</td>
<td>General with specifics</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Some</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Shafer, Smoyer, McCluskey, Beck, Philps (1975)</td>
<td>General with specific examples</td>
<td>Yes</td>
<td>Must make provision for meeting patients' physical and spiritual needs and families' emotional and spiritual needs. Explain to patient what doing. Talk as if the patient can hear (p. 187).</td>
<td>No</td>
<td>Some</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Heltzer, Abballeh; Kitchens (1976)</td>
<td>General, some specifics</td>
<td>Yes</td>
<td>Very Little.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Nodel, Giblin, Wayner (1976)</td>
<td>General with some specifics</td>
<td>Yes</td>
<td>Prevent discussion of condition within hearing. Talk to patient. Tactile contact is often reassuring to the unconscious patient. Need for conversation, pleasant surroundings and adequate stimulation (p. 280).</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Zschocho (1976)</td>
<td>General with examples</td>
<td>Yes</td>
<td>Reality orientation when confused (p. 591).</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Purchase (1977)</td>
<td>General with some specifics</td>
<td>Yes</td>
<td>Little.</td>
<td>&quot;Hearing is the first sense to return when a patient begins to surface from unconsciousness and a familiar voice may be particularly stimulating although there is no outward sign from the patient.&quot; (p. 212)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Adams (1977)</td>
<td>Yes</td>
<td>Yes</td>
<td>Patient may be cognizant of his surroundings. Can recall details of care while supposedly unconscious. &quot;Treat every comatose patient as you would a conscious one.&quot; (p. 27)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Howe (1977)</td>
<td>Yes</td>
<td>Yes</td>
<td>&quot;Patient aware of surroundings while unresponsive, neurologic function pertaining to expression and comprehension are related but not identical. Respect for the patient's humanity.&quot; (pp. 145-146)</td>
<td>No</td>
<td>No</td>
<td>Some</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Hudak, Lohr, Gallo (1977)</td>
<td>General</td>
<td>Yes</td>
<td>&quot;The probability that some unresponsive patients are also unconscious is very likely. However, in view of the current lack of ability to make such an assessment, the only logical approach for nurses to take is that no patient is unconscious. From that assumption the care required is the same as that needed by the patient with an intact communication process.&quot; (p. 61) &quot;All senses should be considered rather than just hearing.&quot; (p. 62)</td>
<td>Direct conversation to him not about him. Use of short, frequent, meaningful input—music, favorite radio station, brief explanation of nursing actions. Use of calendar and clock (p. 420).</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Hakow (1979)</td>
<td>Head trauma</td>
<td>Yes</td>
<td>Respiratory</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<tbody>
<tr>
<td>Jones (1979)</td>
<td>Head Injury</td>
<td>Not Specifically</td>
<td>Not Specifically</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Glasgow Coma Scale</td>
<td>&quot;The greatest recovery is noted in the 6-month period following injury, and that after that time improvement is very rarely sufficient to move a patient to a higher category than that in which he is found at 6 months. Not all authorities agree completely, however.&quot; (p. 196)</td>
</tr>
<tr>
<td>Parsons-Smith (1979)</td>
<td>Acute Cerebral Stroke</td>
<td>Yes—use of dexamethasone early in treatment of stroke. Plea for intensive nursing and medical care.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Glasgow Coma Scale</td>
<td>No</td>
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</tr>
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<tbody>
<tr>
<td>Pemberton (1979)</td>
<td>Yes, in detail</td>
<td>&quot;To see the patient as a whole person with physical, psychological and spiritual needs--is to see the need for a team approach to work towards his recovery.&quot; &quot;The nurse must remember that he is unable to communicate but is likely to hear and understand what is said (unless there is damage to the auditory or speech centers in the cortex.)&quot;</td>
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<tr>
<td>Rice; Jane Edlich (1979a)</td>
<td>Trauma</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Glasgow Coma Scale</td>
</tr>
<tr>
<td>Rice; Jane Edlich (1979b)</td>
<td>Trauma</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
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</tbody>
</table>

"Sleep and rest are necessary to restore mind and body, and the nurse must be able to differentiate sleep from unconsciousness. Knowledge of the patient's normal sleep pattern may be useful, as an assessment of the result of continual disturbance of the patient may show detriment to his recovery, ... marked psychological changes and muscular weakness result from sleep deprivation. The writer holds the view that continual disturbance of the unconscious patient can be detrimental to his recovery." (p. 43)
### Table 1, continued

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Etiology of Coma</th>
<th>Physical and Preventive Care</th>
<th>Psychological Care</th>
<th>Arousal Regimen</th>
<th>Reference to Sleep Wakefulness Cycles</th>
<th>Long Term Care Discussed</th>
<th>Levels of Consciousness</th>
<th>Prognosis of EEG Stages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sigsbee; Plum (1979)</td>
<td>General</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Turner (1979)</td>
<td>Anything Causing Increased ICP</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Tyson; Rime; Winn; Butler; Jane (1979)</td>
<td>Head Injury</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Brunner; Suddarth (1980)</td>
<td>General</td>
<td>Yes</td>
<td>&quot;Speak softly to patient, calling him by name.&quot; &quot;Touch him as gently as possible.&quot; (p. 1194)</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Clifton; Grossman; hakela; Miner; Handel; Sadhu (1980)</td>
<td>Closed Head Injury</td>
<td>Only to Indicate treatment given.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Some Glasgow Coma Scale (GCS)</td>
<td>Patients with a GCS of 8 or less after excluding those who met the criteria for brain death at or soon after admission had a mortality of 29%. There was a 10% mortality for those surviving the first 48 hours.</td>
<td></td>
</tr>
<tr>
<td>George (1980)</td>
<td>Head Injury</td>
<td>Yes</td>
<td>Orient as to time and place.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Luckman; Sorensen (1980)</td>
<td>General</td>
<td>Yes</td>
<td>Remember patient may hear and teach the family this (p. 540).</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Note: GCS = Glasgow Coma Scale.
<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Etiology of Coma</th>
<th>Physical and Preventive Care</th>
<th>Psychological Care</th>
<th>Arousal Regimen</th>
<th>Reference to Sleep Wakefulness Cycles</th>
<th>Long Term Care Discussed</th>
<th>Levels of Consciousness</th>
<th>Prognosis of EEG Stages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hitchel (1980)</td>
<td>Eleven studies considered with a large variety of causes involved.</td>
<td>Yes. Deals specifically with intracranial pressure (ICP) and things which may cause elevation in ICP such as: Head rotating, neck flexion, turning, etc.</td>
<td>Some data shared to indicate that emotional arousal/emotionally referenced conversations (conversation about condition) may increase ICP.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Phipps; Long; Woods (1980)</td>
<td>General</td>
<td>Yes</td>
<td>Addressed by appropriate title, positive comments made in hearing range but not negative, external environment--soothing, noise at minimum, music for age, touch in firm grasp, smoothing hair away, etc. (p. 211).</td>
<td>Only as in psychosocial care.</td>
<td>No</td>
<td>Some</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Taylor; Ballenger (1980)</td>
<td>General with specific examples given.</td>
<td>Yes, in detail.</td>
<td>One of four goals of nursing management is for patient and family to develop trust and confidence in the health care.</td>
<td>Suggests reorientation in earliest contacts; suggests making stimuli meaningful and significant--using touch, odors, taste, as well as talking to the patient.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
Summary

A critical review of a portion of the literature on coma and nursing care of the comatose patient was presented. The review included sections on factors affecting coma or its assessment post onset, treatment of coma, the EEG in coma, prognosis of the comatose patient and states resembling sleep/waking in comatose and normal adults and adolescents. The review of nursing literature included sections on etiology of coma, physical and preventive care, psychological care, arousal regimen, reference to sleep wakefulness cycles, the discussion of long-term care, levels of consciousness and the prognostic value of EEG stages.
Chapter 3

METHODOLOGY

This study was designed and directed by Evelyn L. Elwell, D.N.Sc., and Annette M. Ross, R.N., M.S. Conducted in cooperation with the above-mentioned principal and co-investigators, this thesis represented a small portion of an ongoing research study entitled "Polygraphic Patterns in Neurological Dysfunction."

The sample for this portion of the study consisted of two patients, one who received systematic orienting stimuli from nurse researchers and one who did not. The data were reported descriptively, in case study format.

Design, Sample, and Setting

This descriptive study was a portion of a quasi-experimental study. The sample was a purposive sample, with random assignment to groups, consisting of those patients who became comatose and met the sample criteria within the time frame of the study. Patients studied were hospitalized at a 538-bed university medical center. All had been comatose for at least six hours and had scored below 8 on the Glasgow Coma Scale. (The lowest possible score is 3.) The acuity of the patient problems involved, and the intensity of care required, produced many confounding variables, some of which were recorded. The independent variable (systematic orienting stimuli) and the dependent variables (the EEG patterns, levels)
on the GCS and outcome criteria) were also recorded. The rationale for controlling the GCS score of patients is discussed in the following paragraph.

In Jennett and Teasdale's (1979) series of 1,000 patients only 30 survived, and those in a severely disabled state. Other authors found the percentage surviving (29%) higher in those with scores below 8, but it was unclear how long the patients remained in coma. Patients who had GCS scores of 3 to 8 on initial examination in the emergency room and who then improved within the first 48 hours were rarely among those who subsequently deteriorated in 124 cases studied by Clifton, Grossman, Makela, Miner, Handel and Sadleu (1980). On the other hand, these authors stated that most patients with scores of 3 to 4 died within 48 hours, and those with scores of 8 or less accounted for 95 percent of the deaths of 558 admitted to the emergency room (Clifton, and Others, 1980, p. 613). Of the 124 patients in their total patient group, Clifton's team studied 54 who scored below 8 on the GCS, and who lived beyond 48 hours but did not awaken prior to 48 hours. Of these patients they stated that although their injuries were severe, they "represent those who appear to have the potential for salvage and consume the majority of clinical resources. . . ." (Clifton, and Others, 1980, p. 613)

Criteria for Selection of the Sample
for the Present Investigation

Patients were not studied:

1. with acute drug or metabolic coma with reasonable expectation of reversal of the coma.
2. below one year of age.

3. with an unstable clinical condition in excess of 144 hours post coma onset.

4. with a history of diencephalic pathology, malignant hypertension, severe systemic disease including end-stage renal or hepatic disease, previous severe head injury, previous brain surgery requiring interruption of neuronal tracts, degenerative neurological pathology such as M.S. or amyolateral sclerosis, or grand mal epilepsy.

5. with a temperature elevation of 104.0°F. at the time initially being considered for inclusion in the study. Patients who developed this temperature after admission to the study were not necessarily dropped from the study.

6. who met the criteria for irreversible coma (electrocerebral silence, brain death), or who had been designated in any way as "no Code," "No Heroics," "No CPR."

7. with pre- or post-operative cerebral tumors which had infiltrated or severed areas believed to contain RAS pathways or a definitive diagnosis of destruction in the region of the locus coeruleus and raphe system nuclei of the brain stem, or with definite fractures of the cervical spine.

8. with identifiable "locked in" syndrome. Such patients were removed from the study unless, in their physicians' opinion, it would have been detrimental to do so.

9. with known moderate or severe hearing problems.

10. who did not understand English.
Method and Sample Selection

Potential patients for inclusion in the study were identified during rounds made twice daily to those nursing units which were considered likely recipients of comatose patients. The nursing staff was very cooperative and accurate in responding to the bi-daily question, "Are there any comatose patients on your unit?"

All comatose patients were initially screened through review of the chart. Patients who met the initial criteria for inclusion into the study were further screened by a neurological assessment using the Glasgow Coma Scale. If the score of the GCS was less than 8, the patient was assigned to a group and the attending physician was approached, the study was explained, and his permission obtained.

The next of kin were then contacted, given a verbal explanation of the research study, and allowed to ask questions. The family was given a copy of the consent form and asked to review it. After the family members stated that they were comfortable with the verbal and written explanations, their signatures were obtained and witnessed on the consent forms (see Appendixes E and F).

Method of Obtaining Consent

The method of admitting patients to the study and obtaining informed consent from their families was enumerated in the following paragraphs. Group assignment was by the table of random numbers for this portion of the study, with even numbers placed in the clinical control group.
Since the unconscious patient could not give informed consent even for procedures which might have been of great benefit to him, the patient's guardian or next of kin was asked to give permission for his/her inclusion in the study. If a comatose patient had no guardian or next of kin and the court had not appointed a responsible party, the patient was not included in this study.

After the patient's physicians had given approval for inclusion of the patient in the study and had verified that the patient's clinical condition was stable, the family of the patient was given a verbal explanation of the study protocol. The family was given the consent form to read and given time alone to discuss the study, etc. The consent form was then retrieved from the family, having been signed (or not) by the next of kin. Physician consent was then obtained in written form on the same consent form. A copy of the consent form was given to the family.

In obtaining informed consent from the patient's next of kin the following information was provided:

1. That the purpose of the study was to find out how deeply comatose the patient was and what would be the best times of the day to give him information, tell him what was going on in the news, talk with him about his hobbies, read to him, and in general try to help awaken him, etc.

2. That the study involved recording how deeply he was "sleeping" and would involve the use of small electrodes which were taped to the skin and head which would not cause the patient any discomfort nor
interfere with his care and would involve the use of an EEG/polygraph machine (EEG/PSG) to record the patient's sleep patterns. (Next of kin would be shown the equipment.) It was emphasized that there was no danger from the electrical equipment. Recording would be continuous for five to six days.

3. That special kinds of nursing care for the patient would be provided including checking his Glasgow Coma Scale score or progress at least twice a day by a neurological nurse specialist. (Although the nurses on the unit remained responsible for total care, the nurse clinicians involved in the research remained with the patient for 50 minutes of each hour for the 144 hours of recording.)

4. That the patients included in the study would have free EEG studies before, during and after the present study which could assist physicians in providing care immediately if the physician could read the EEG. The results of these studies would be made available on the patients' charts after they were scored (one to two weeks later). The EEG would be explained to the next of kin when necessary. The EEGs would be available to physicians immediately in the neurologist's office.

5. That there were no known risks to the patient from the study. If the patient should begin to awaken and become restless and the small wires or electrodes seemed to be causing him any added discomfort they would be removed if the next of kin requested it or if the nurse-researchers, the staff nurses or the patient's physician thought it to be advisable. The next of kin were cautioned against hoping too much about the recovery of the patient as a result of the study. NOTE: The
patients in the comparison group received routine care as usual, so explanation for informed consent for the comparative group stopped here.

6. That the nurse researchers would ask the next of kin for a history of the patient's likes, dislikes, activities, behaviors, work in general, and some specific questions about the patient's hobbies and the way he usually spent his time when not working so tapes could be made to play to him during normal waking hours. This information would be kept confidential and the patient's privacy would be protected. Earphones would be used to play tapes to the patient after the volume was tested by two nurses. Information on the nursing history would be taken from the patient's chart when possible or obtained by the nurse to avoid requiring the next of kin to supply information which he had already made available, most likely to several people. The family or next of kin would also be invited to make a tape recording of their voices which could then be played back to patients at times when the family was absent. These and other stimuli would be taught to the family if they wished to learn. This would not be mandatory but voluntary on the part of the family. A special tape of the person's mother's voice would be requested regardless of the patient's age.

7. That the report of the results of the study would respect the privacy of the patients and their families and their names would not be connected with the data in its final published form. Any photographs made would be made unidentifiable using a black band across the eyes.

8. That the patient would not receive stimuli during the night
except when it was necessary to take his/her vital signs, to provide the usual time for rest and encourage normal sleep patterns.

**Data Collection Procedures and Instrumentation**

Demographic data included patient's age, sex, marital status, religion, and admitting diagnoses. Other information included results of the physical examination, laboratory data, and medications. All was obtained from the patient's chart. Additional information relevant to the patient's past habits, likes and dislikes was sought from the family.

The initial EEG was done within 72 hours of onset of coma. After this time, one of five researchers was with the patient 50 minutes out of every hour for the next 80 hours. During this time, vital signs, neurological assessment (including GCS), and daily EEGs were performed. As well, orienting stimuli were presented every hour during regular waking hours to the experimental patient.

The family members of the experimental patient cooperated very willingly in providing reorienting stimuli. They made tapes of favorite music, voices and sounds. They also brought in pictures, favorite cologne and samples of home cooking (lemon pie and taco sauce). Family visitation was regular and supportive; after some coaching by the researchers, touch and conversation were lovingly and consistently directed toward the patient. When family members were present with the patient, their visitation was considered the reorienting stimulus for that hour. However, when the family was not present, or when
nursing care was given directly to the patient, the research staff used touch, verbal explanations and tapes to provide stimulation for the patient.

While the research staff did not engage in the same direct provision of an hourly stimulus for the control patient, his mother spontaneously provided a variety of reorienting stimuli, including talking and reading to him, playing music to him, touching him, and letting him feel favorite objects.

Using the Beckman portable electroencephalograph, a daily EEG was done on both patients using the International 10-20 lead placement. The final EEG was done on the 14th to 17th day after onset of coma. All EEGs were read and scored by Dr. Guy Hunt. Level of arousal was also measured by hourly assessment according to the Glasgow Coma Scale. (See Figure 1.)

Methodological Assumptions

Several additional methodological assumptions were made for this portion of the study. It was assumed that

1. comatose patients received stimuli and the human brain remained receptive although consciousness was altered.
2. environmental enrichment was beneficial.
3. nursing therapies were beneficial.
4. S.O.S. were beneficial.
5. presence of participant observers did not alter patient care positively or negatively.
<table>
<thead>
<tr>
<th>6-72 Hours After Onset of Coma</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Chart review; neurologic assessment using GCS</td>
</tr>
<tr>
<td>2. Physician consent</td>
</tr>
<tr>
<td>3. Informed consent from next of kin</td>
</tr>
<tr>
<td>4. Portable EEG</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Next 80 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Continuous attendance by research staff (50 min. out of each hour)</td>
</tr>
<tr>
<td>2. Orienting stimuli hourly to experimental patient during waking hours</td>
</tr>
<tr>
<td>3. Teach family, significant others to do orienting stimuli</td>
</tr>
<tr>
<td>4. Biochemical data from chart</td>
</tr>
<tr>
<td>5. Daily portable EEG</td>
</tr>
<tr>
<td>6. Hourly GCS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>End of Study, Day 14 or 17 POC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Portable EEG</td>
</tr>
<tr>
<td>2. Neurologic assessment without orienting stimuli</td>
</tr>
<tr>
<td>3. GCS</td>
</tr>
<tr>
<td>4. Biochemical data from chart</td>
</tr>
</tbody>
</table>

Figure 1
Research Plan
6. EEG patterns identified by the neurologist were correct.
7. the protocol of the study did not result in any additional risk not already inherent in routine nursing care for the comatose patient.
8. the portable EEG machine was run and calibrated correctly.

**Limitations**

The multiplicity of confounding variables which could not be controlled would have severely limited this study even if the sample size had been larger. In addition to those listed in Chapter 1, the following factors were believed to represent limitations to the successful completion and generalization of the findings of this study.

1. Inability to control major confounding variables including, but not limited to, the placement of patients on different types of intensive care or non-intensive care units; care of different medical and surgical staff; care of different nurses; presence of absence of family; need/desire on part of family to provide orienting stimuli; extent of post coma complications; extent and existence of pre-coma dysfunction; pre-coma cognitive abilities and psychological state, including overwhelming recent stress or loss; history of smoking and drug abuse and their potential impact on the outcome of coma (Elwell; Ross, 1980).

2. Inability to collect data for more than a three-month period because of personal obligations which limited sample size, especially since patients who met the criteria for selection of the sample were not available during one month of that time.
3. Inability to control environmental lighting to produce more normal light/dark cycles.
4. Inability to control influence of presence of researchers among nursing personnel, their attitudes and behaviors toward patient care, either positively or negatively.
5. Inability of the researchers to obtain blind scoring of the serial EEGs which may have influenced/biased the EEG findings.
6. Inability of the researchers to monitor the accuracy of measurements made and recorded by the nursing staff.
7. Equipment sensitivity to artifact and inaccuracies in calibration.
8. Inability to control meaningless stimuli to patients.
9. Contamination of control group.
10. Researcher fatigue.

**Summary**

The methods and procedures used to collect data with the patients included in this study were described. As part of a larger study the design, sample selection and setting were discussed. Similarly, pertinent limitations and assumptions were enumerated. The data obtained were presented in Chapter 4. Formal data analysis was not possible with the small sample reported.
Chapter 4

PRESENTATION AND DISCUSSION OF DATA

This portion of the research study was descriptive in nature. The data collected were presented using the case study approach. No attempt was made to generalize or explain the findings in these patients.

The demographic data and admitting medical diagnoses of the patients included in the study were compiled in Table 2. As shown in Table 2, both patients were young males injured by vehicular trauma.

**Case Study of Patient A**

Patient A was admitted to the experimental group by random number assignment. The study was initiated approximately 72 hours after loss of consciousness (LOC) first occurred. In this instance the next of kin was the patient's mother. The procedure for informed consent, however was initiated with his mother, his twin sister, and his oldest brother. The consent to include the patient in the study was granted by his mother, but was a decision of the family members present.

**Social History**

Patient A was a 22-year-old Caucasian male who had been married for four years and had been separated from his wife only six months prior to his admission. Final proceedings for their divorce
Table 2  
Comparison of Demographic Data for Patients

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>Sex</th>
<th>Marital Status</th>
<th>Occupation</th>
<th>Religion</th>
<th>Admitting Medical Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>22</td>
<td>M</td>
<td>Separated</td>
<td>Unemployed</td>
<td>Protestant</td>
<td>Multiple trauma</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Cerebral concussion</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Possible fracture T 5-6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Open comminuted fracture of right fibula and tibia</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Head injury with open wound</td>
</tr>
<tr>
<td>B</td>
<td>16</td>
<td>M</td>
<td>Single</td>
<td>Student</td>
<td>Protestant</td>
<td>Basilar skull fracture</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Intracerebral hemorrhage</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Post traumatic seizures</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Open comminuted left femur fracture</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fractured clavicle</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fractured mandible</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Teeth missing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Multiple lacerations and abrasions of arms and face</td>
</tr>
</tbody>
</table>
were due to take place one month after his traumatic incident. His ex-wife came to the hospital on one occasion only.

The immediate family consisted of his mother, a twin sister, two brothers, and his two-year-old son. Significant others included a fiancée, and many other friends. A man who identified himself as A's father called the hospital unit on several occasions. The patient's mother described the father as an alcoholic.

**Current Medical History and Study Involvement**

Prior to this admission, Patient A had been in good health. Hospitalization on this occasion was because of multiple trauma sustained when he was a pedestrian struck by a rapidly-moving vehicle. Friends stated that he had taken 40 mg. of Valium just before he was involved in the accident.

On July 11, 1980, at 2149 hours, Patient A was brought to Loma Linda University Medical Center (LLUMC) Emergency Room comatose and suffering from multiple trauma. He had sustained a cerebral concussion, a 3 x 4 cm. open wound on the right side of his forehead, and a fracture at T5-T6 was suspected. His respirations were spontaneous and pupils were equal, round and reactive to light. In the Emergency Room (ER) he displayed some response to deep pain.

Whereas minimal movement of the right lower extremity was noted, the left lower extremity decerebrated to pain. Besides multiple abrasions on his arms, back and left leg and foot, he had a severe open comminuted fracture of the right tibia and fibula. For the latter, he was taken directly from the ER to the Operating Room (OR) for irrigation, debridement, reduction and external skeletal fixation.
Two days after admission computerized axillary tomography (CT scan) showed mild cerebral edema but no evidence of a bleed or other focal lesion. X-rays of the spine ruled out the suspected fracture of T5-T6.

Patient A was included in the research on July 14, 1980. Nurse researchers remained with him 24 hours per day for three days. He was presented with orienting stimuli for 10 to 15 minutes every hour from 8 a.m. until 10 p.m. Besides family visitation, this stimuli consisted of tapes of family conversation (including verbalizations of his 2-year-old son), tapes of his favorite rock music, a picture of his son, applications of his favorite cologne, and "tastes" of favorite foods including taco sauce, honey, and his mother's homemade lemon pie. Family members were encouraged to participate in the reorienting stimuli. At first they found this very difficult, but with support and practice, they looked forward to providing him with stimuli.

For two weeks the patient remained deeply comatose. During this time he manifested increasing pulmonary congestion which progressed into pneumonia. Early in the third week (July 26, 1980) a consulting neurosurgeon stated that because of his early decerebrate posturing Patient A's prognosis was very guarded. On July 28 the attending physicians agreed that A's prognosis was indeed poor. Because of his compromised pulmonary status, Patient A was placed on a circo-electric bed on July 30. Four days later it appeared that he attempted to lift his chest off the bed by pushing downward with his arm when proned. The next day a transverse fracture through the
navicular bone of his left wrist was diagnosed by x-ray and subsequently casted.

By the end of the first week in August, his pneumonia was resolving and he was evaluated for transfer out of the Intensive Care Unit (ICU). On August 12, definite signs of lightening coma were evident. Although not in response to command, he squeezed and let go of a nurse's hand three times. The same day he opened his eyes several times when called. The following day he was able to squeeze and release his hand to command. He also demonstrated an interest in his surroundings by looking around. During all of this time the systematic orienting stimuli were provided by the family as taught by the nurse investigator. On August 15, although making no attempt to speak, he did shake his head "Yes" or "No" in appropriate response to questions. Two days later and 37 days after the onset of coma, he began attempting to verbalize. His speech was labored, slow, and very slurred, but his twin sister understood him to say, "I love you."

At this time he also began manifesting emotional responses by hugging and kissing his mother and sister. He waved appropriately when waved to and held and kissed the picture of his son. The next day his family claimed that he requested "a cold beer and a burrito." He showed a definite interest in oral feedings, devouring any jello and ice cream that was offered to him.

A week later his speech was still very difficult to understand, but in response to questions from the occupational therapist, he answered 75 percent correctly by shaking his head "yes" or "no." Within two days he was able to choose the correct response to problems of
addition. On August 26, at his request, he spent his first hour and a half out of bed in a chair.

September 2 marked 53 days from the onset of coma. Although still not oriented to time and place, Patient A's speech had improved to the point that it was mostly understandable. On September 3 he was able to verbalize his name in response to inquiry by health professionals. On September 4 he was discharged to a rehabilitation center in nearby San Bernardino. The same day he was sent to the physical therapy department to begin treatments. After six weeks at the rehabilitation center he had gained considerable independence in activities of daily living and was discharged to home. The rehabilitation physician remarked that his progress had been "much faster than expected."

After his discharge, Patient A's ambulation was limited by the incomplete healing of his right leg which necessitated that the external fixation device remain on his leg until early January. After its removal, he was still confined to ambulating with a walker until the orthopedic surgeon was satisfied that sufficient healing had taken place to enable him to bear full weight on his right leg.

Patient A experienced considerable emotional readjustment which seemed to be complicated when his fiancée terminated their relationship in November. Whereas he claimed that she was "embarrassed to take me places in the wheelchair," she confessed that A seemed to have "changed a lot" since his accident. Patient A stated that he had attempted suicide after his girl friend left him. Thereafter he was able to meet some of his emotional needs by spending considerable time conversing on the telephone. Diplopia limited his ability to
concentrate on close work such as reading, but by covering his left eye with a patch, he was able to spend time watching television. He refused to attend speech therapy because he said it made him feel "dumb." His speech continued to be difficult to understand at times, although he was able to make himself understood over the telephone.

**Electroencephalogram Reports**

The electroencephalograms (EEGs) were done on Patient A between July 14 and July 25, 1980. The first and last EEGs were done using a 10-montage EEG. A 3-montage EEG was used for the rest of the electroencephalograms. The International 10-20 lead placement was used. The results reported here are from the neurologist's interpretation.

**EEG number one.** The first EEG was done on July 14, 1980, at 2200 hours. A review of this tracing revealed it to be abnormal with almost constant slow wave activity of 3-5 cycles per second, intermixed with some activity in the beta and alpha range. The alpha frequency range waves were not organized and no normal runs of alpha activity were noted. The beta activity also was irregular, varying from 15-25 cycles per second. Since this tracing was run under ICU conditions it was marred by many artifacts, due to movement within the room, etc. In the bipolar combinations the amplitudes tended to be quite low, seldom exceeding 20 microvolts. The slower wave forms tended to be somewhat higher in amplitude than the more rapid frequencies. Throughout the tracing no definite localization or lateralization of the irregularities noted were seen.
The neurologist's impression was that this was an abnormal electroencephalogram without localization or lateralization. He stated that the tracing suggested a generalized involvement of the brain, consistent with cerebral edema or some other generalized process.

**EEG number two.** The second EEG was done on July 15, 1980, at 2100 hours. A review of this tracing revealed it to be poorly regulated. There was no visible alpha activity, though occasionally a few waves in the alpha range were noted. The dominant frequency was in the beta range of 15-20 cycles per second (cps). Throughout the tracing frequent high amplitude slow waves were noted. These were as slow as 2 cps but occasionally were as fast as 4 cps. These were noted particularly from the frontal regions but were seen from other parts of the hemispheres. The slow wave activity tended to occur in bursts though no sharp wave activity was seen with them. No consistent localization or lateralization was noted, though as mentioned, the greater amplitudes were noted from the frontal regions.

The neurologist's impression was that this was an abnormal electroencephalogram of moderately severe degree, without consistent localization or lateralization. He stated that the tracing was consistent with some generalized involvement of the brain, though the greater amplitudes noted from the frontal regions may have suggested greater involvement in those areas.

**EEG number three.** The third EEG was done on July 16, 1980, at 2200 hours. A review of this tracing revealed it to be very poorly regulated without consistent alpha activity. However, this tracing
showed improvement as far as the amount of high amplitude slow wave activity seen. Slow waves were still noted, but they were seldom slower than 3 cps. Amplitudes were somewhat less than in the previous tracing. The beta activity of about 15-20 cps was still prominent. No definite localization or lateralization were noted. Amplitudes were still a little greater from the frontal regions. The neurologist's impression was that this was an abnormal electroencephalogram which showed some improvement over the previous tracing.

**EEG number four.** The fourth EEG was done on July 17, 1980, at 2130 hours. A review of this tracing revealed it to be poorly organized with no well established alpha rhythm. The dominant frequency continued to be in the beta range of about 15 cps. Throughout the tracing frequent slower, higher amplitude waves occasionally exceeding 100 microvolts were noted. These were perhaps a little less frequent than in the previous tracing, though there had been no marked change.

The neurologist's impression was that this was an abnormal EEG showing perhaps slight improvement over tracing number three. He stated that the progress in these three tracings suggested some improvement in the brain wave activity but the tracings remained poorly regulated with no well-established alpha rhythm.

**EEG number five.** The fifth EEG was done on July 18, 1980, at 2000 hours. The tracing was run under ICU conditions and was marred by much artifact, particularly 60 cycle interference. At times, however, this disappeared and one could see the underlying pattern which
consisted of irregular waves which tended to be in the beta range with occasional waves in the theta range. Amplitudes were low, seldom exceeding 20 microvolts. No consistent localization or lateralization of the abnormalities were noted. On a few occasions the tracing was characterized by higher amplitude slower waves down to 3 or 4 cps. These again occurred from all leads and combinations though occasionally seeming slightly greater from the right anterior temporal region. The slower waves occasionally exceeded 100 microvolts.

The neurologist's impression was that this was an abnormal EEG with mild localization to the right anterior temporal region. He stated that this tracing was much like the original tracing but showing more evidence of cortical activity and some localization of the greater irregularities to the right anterior temporal region.

**EEG number six.** The sixth EEG was done on July 25, 1980, at 1830 hours. A review of this tracing revealed it to be marred by many artifacts, including both muscle potential and machine artifacts. An evaluation of the underlying pattern, however, revealed it to be fairly well regulated with a basic alpha rhythm of 10-12 cps which was noted quite consistently. Amplitudes tended to be low, seldom exceeding 25 microvolts. However, there was some amplitude asymmetry with higher voltages noted from the right hemisphere. Occasional slower waves, usually in the theta range, were noted. No localization or lateralization was seen.

The neurologist's impression was that this was an essentially normal electroencephalogram. He stated that there was no definite
evidence of organic disease of the brain noted in the tracing and that the mild amplitude asymmetry was probably not of significance.

**Case Study of Patient B**

Patient B was admitted to the control group by random number assignment. The study was initiated approximately 72 hours after loss of consciousness first occurred. Patient B's next of kin was his mother. It was she who granted consent to include the patient in the study.

**Social History**

Patient B was a 16-year-old single Caucasian male. Prior to this hospitalization he had enjoyed the healthy active life typical of a high school student. He especially enjoyed working with his hands doing auto mechanics and auto body repair. His mother stated that although scholastically he had been classified as a slow learner, she thought that his "attitude" and "stubbornness" had a lot to do with his "slowness."

Significant others consisted of his mother, grandmother, and many high school friends, both male and female. He was also visited frequently by an aunt who had, at age 19, been comatose herself for 16 days as a result of injuries sustained in an automobile accident. Not only had she made an excellent recovery, but her experience had served to spark an intense family interest in the care and prognosis of comatose patients.
Current History and Study

Involvement

Patient B was brought to the emergency room on July 20, at 1715 hours after the car he had been driving collided with a tree. Rescue attempts had been difficult and he remained unconscious and pinned in the vehicle for 45 minutes before being freed by his rescuers. During the ambulance ride to the hospital he was actively seizing. In the emergency room neurologic exam revealed pupils that were small and minimally reactive to light, decerebrate posturing, increased deep tendon reflexes and bilateral positive Babinski.

Upon visual examination it was noted that his right eye was wandering and that his left eye had considerable periorbital ecchymosis. An x-ray of the head revealed a fracture of the posterior wall and floor of the left orbit which extended into the floor of the left intracranial fossa. Hemorrhage was present. There were also prominent subarachnoid hemorrhages, although they were not considered significant enough to warrant burr holes.

Other injuries included an open mandible fracture and missing teeth. He had sustained multiple lacerations and abrasions of the arms and face. He also had an open comminuted fracture of the left femur which was held in reduction by external Buck's traction.

On admission to the ICU Patient B was placed on a respirator for ventilatory support. During the first two days of hospitalization the patient's level of response deteriorated so it was decided to monitor his intracranial pressure by placing an ICP device. Multiple
episodes of increased intracranial pressure were therefore apparent on the monitor and were subsequently treated with diuretics and steroids.

Four days after admission Patient B was taken to surgery for open reduction and internal fixation of his left femur fracture. Since he continued to require ventilatory support, a tracheostomy was also performed at that time.

The week following admission the patient became slightly more responsive and occasionally gripped to command. Follow-up CT scans, the latest done on August 7, revealed decreased visualization of the previously-described subarachnoid hemorrhages and moderately increased lateral, third, and fourth ventricular size. In order to rule out a mild communicating hydrocephalus, a lumbar puncture was performed. Opening pressure was within normal limits.

In the successive weeks the patient's condition continued to stabilize. Physical therapy was performed at the bedside to maintain joint function. The patient became more alert and responsive. Although he made no attempts to verbalize, perhaps due to the tracheostomy, he did attempt to answer questions by eye blinks. He appeared emotionally labile, fluctuating between apathy, uncooperativeness and euphoria. He appeared most responsive when visited by school friends. At that time he would smile and laugh out loud.

On September 2, 44 days after the initial insult and loss of consciousness, Patient B was discharged to a community rehabilitation center. That same day he was sent to the physical therapy department for therapy. Two weeks later his tracheostomy tube was removed and he immediately began verbalizing. His monotone speech was very difficult
to understand so speech therapy was instituted. On November 17, 76 days after his transfer to the rehabilitation center and 120 days after the initial loss of consciousness, Patient B was discharged to home. He was able to ambulate, although he required a walker to compensate for a deficit in balance. He had achieved partial independence in activities of daily living, although some residual paralysis of his left upper extremity created limitations, especially since he was left-handed. His speech remained a monotone and was very difficult to understand.

After discharge, B's mother continued to encourage her son's recovery. She arranged for him to have a "home teacher" whereby he could continue his academic studies at home. His scores on the "RAT" test, a test of mathematical, reading and comprehensional skills, done about one month prior to his accident and then again after his discharge from the rehabilitation center, indicated very little change in his mental aptitude, and ruled out mental retardation. With this encouraging indicator, the school district supplied the family with an electric typewriter. It was hoped that Patient B's communication skills would be enhanced by his mastering the use of the typewriter. At the encouragement of his mother, Patient B has also become involved in the following activities: swimming lessons at the YMCA two nights each week, horseback riding on a daily basis, and an occasional camping trip.

**Electroencephalogram Reports**

The electroencephalograms were done on Patient B between July 23 and August 6, 1980. The first and last EEGs were done using a 10-montage
EEG. A 3-montage EEG was used for the rest of the electroencephalograms. The International 10-20 lead placement was used for all EEGs. The results reported here are from the neurologist's interpretation.

**EEG number one.** The first electroencephalogram was done on July 23, 1980, at 1600 hours. This tracing was done under ICU conditions and was marred by some artifacts, particularly 60 cycle interference. However, during much of the tracing a basic pattern could be seen which was abnormal, consisting of high amplitude slow waves, varying between $2\frac{1}{2}$ and 5 cycles per second. This activity was noted in all leads and combinations but was more marked from the frontal regions, slightly greater on the left and from the temporal regions more marked on the right. Amplitudes were more often over 100 microvolts and occasionally reached 200 microvolts. This was primarily the higher amplitude slow waves seen in the frontal regions. Occasional waves in the alpha range were seen but no good runs of this activity were noted.

The neurologist's impression was that this was an abnormal EEG with generalized slowing but with greater activity from the frontal regions and the right temporal region. The neurologist stated that the abnormalities noted in this tracing were consistent with traumatic brain injury.

**EEG number two.** The second EEG was done on July 24, 1980, at 0830 hours. A review of this tracing revealed it to be quite abnormal with almost constant slow wave activity, down to 2 cps. Much muscle potential artifact was noted. Rarely some activity within the alpha
range was noted at about 10 cps. Amplitudes varied greatly, occasionally exceeding 150 microvolts. The higher amplitude slow wave activity was somewhat greater from the frontal regions, but there was no definite lateralization.

The neurologist's impression was that this was an abnormal EEG characterized by constant high amplitude slow wave activity, greatest from the frontal regions, bilaterally. He stated that the abnormalities noted in this tracing were consistent with some organic involvement of the brain, particularly in the frontal regions. No lateralization was noted.

EEG number three. The third EEG was done on July 25, 1980. A review of this tracing revealed it to be quite abnormal with rather constant high amplitude slow wave activity, greatest from the frontal regions. It was similar to the tracing done the previous day. However, the slow wave activity was perhaps slightly lower in average amplitude and perhaps occurred less frequently. Usual amplitudes were below 150 microvolts. Occasional waves in the alpha and theta range were noted. The tracing was marred by much movement and muscle potential artifact.

The neurologist's impression was that this was an abnormal electroencephalogram, characterized by slow wave activity from the frontal regions bilaterally. He stated that the tracing was similar to that run on July 24, but showed some mild overall improvement.

EEG number four. The fourth EEG was done on July 26, 1980. A review of this tracing revealed it to be quite abnormal with rather
constantly occurring high amplitude slow wave complexes. However, the tracing showed a definite improvement over the previous two tracings, as more activity in the theta range was noted. This improvement was particularly noted from the right frontal region, though the right frontocentral region continued to exhibit the higher amplitude slow wave activity. Occasionally some more rapid waves in the beta frequency of about 15 cps were noted.

The neurologist's impression was that this was an abnormal electroencephalogram with generalized slow wave activity from the frontal regions. He stated that this tracing, though comparable to previous tracings, continued to show some gradual improvement in the pattern.

**EEG number five.** The fifth EEG was done on July 27, 1980. It again showed much high amplitude slow wave activity. This continued to be greater from the frontal regions. This extended backward over the hemispheres, but was not as prominent in the right temporal region as the first tracing. Interspersed with the slow waves was more activity in the alpha and theta range than previously noted.

The neurologist's impression was that this was an abnormal electroencephalogram with generalized slowing but with some localization to the left hemisphere anteriorly. He stated that the tracing was similar to that run originally on the patient, but appeared to show some improvement in brain function. The localization of the greater abnormalities was more to the left hemisphere in this tracing, although it continued to be consistent with a rather general trauma, particularly to the frontal and temporal poles.
EEG number six. The sixth EEG was done on August 6, 1980, at 1000 hours. A review of this tracing revealed it to be moderately abnormal with no well-established alpha rhythm. The dominant frequency was, however, in the theta range of about 6 cps. Occasional slower waves were noted, but these were much less frequently seen than in the tracings run earlier on this patient. Occasional short runs of alpha activity of about 10 cps were seen. The slow wave activity, though noted from both frontal and central regions, was perhaps slightly greater from the left frontocentral combination.

The neurologist's impression was that this was an abnormal EEG, characterized by poor regulation and frequent slow wave activity, primarily from the frontal regions. He stated that this tracing remained quite abnormal but showed a marked improvement over previous tracings, with more activity in the alpha and theta range. The slow activity was less prominent, less frequent and of lower amplitude. The localization continued to be to the frontal regions, or frontocentral areas.

Comparison of Patient Data

A comparison of the data and post study outcomes from the two comatose patients is found in Table 3. Examination of the data in Table 3 reveals that the etiology of coma for both study patients was the same. Although the patients' initial Glasgow Coma Scale scores were similar, by days 14 and 17 post onset of coma, increasing differences were noted. Both patients demonstrated improvement in the results of the EEGs. At the end of the study Patient B demonstrated an improvement in all three areas: his clinical picture, Glasgow Coma Scale
## Table 3
Comparison of Data and Post-Study Outcomes of the Two Comatose Patients

<table>
<thead>
<tr>
<th>Data</th>
<th>Patient A</th>
<th>Patient B</th>
</tr>
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<tbody>
<tr>
<td>Age/Sex</td>
<td>22/M</td>
<td>16/M</td>
</tr>
<tr>
<td>Etiology of Coma</td>
<td>Head</td>
<td>Head</td>
</tr>
<tr>
<td>Handedness</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>Time from Insult toFirst EEG</td>
<td>71 Hours</td>
<td>72 Hours</td>
</tr>
<tr>
<td>ConditionInitial EEG</td>
<td>Comatose</td>
<td>Comatose</td>
</tr>
<tr>
<td>Initial EEG Findings</td>
<td>Pupils Reactive to Light</td>
<td>Decerebrate Posturing</td>
</tr>
<tr>
<td>Initial GCS Score</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Initial EEG Findings</td>
<td>Almost constant slow wave activity (3-5 c/s) with some alpha and beta waves. Alpha not organized, no normal runs. Beta irregular (15-25 c/s). No definite localization or lateralization of the irregularities. Bipolar combinations--amplitudes seldom exceed 10 m/v.</td>
<td>High amplitude, slow waves (2 1/2-5 c/s) more marked in left frontal region and right temporal region. Amplitudes often &gt;100 m/v, sometimes 200 m/v. Occasional alpha waves.</td>
</tr>
<tr>
<td>Condition on Final Day of Study</td>
<td>Comatose</td>
<td>Semi-comatose</td>
</tr>
<tr>
<td>GCS Scores on Final Day of Study</td>
<td>3</td>
<td>9</td>
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</table>
Table 3, continued

<table>
<thead>
<tr>
<th>Data</th>
<th>Patient A</th>
<th>Patient B</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEG Findings</td>
<td>Fairly well regulated. Basic alpha rhythm of 10-12 cps. Low amplitudes,</td>
<td>Poorly regulated. Dominant frequency in the theta range of about 6 cps. Occasional slow waves of lower amplitude than initial EEG.</td>
</tr>
<tr>
<td>on Final Day of</td>
<td>seldom exceeding 25 m/v. Amplitude asymmetry from right hemisphere at</td>
<td>Occasional short runs of alpha of about 10 cps. Localization to the frontal regions or frontocentral areas.</td>
</tr>
<tr>
<td>Study</td>
<td>higher voltages. Occasional lower waves (theta). No localization or</td>
<td></td>
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<tr>
<td>Post Study</td>
<td>Consciousness began returning 31 days POC. By Day 37 POC he started</td>
<td>Transferred to a rehabilitation center on September 2, 42 days POC after slowly regaining consciousness over a period of about two weeks.</td>
</tr>
<tr>
<td>Outcome</td>
<td>verbalizing. Discharged to rehabilitation center on September 4, 55 days</td>
<td>After 75 days at the rehab center he was discharged to home on November 17. Able to walk with walker—unsteady on feet. RAT test showed</td>
</tr>
<tr>
<td></td>
<td>POC. After 66 days returned to mother's home on November 10. Good</td>
<td>no mental retardation. Speech poor. Moderate limitations, mostly apparent in compromised hand coordination.</td>
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<tr>
<td></td>
<td>recovery, able to walk with walker. Functional, moderate limitations,</td>
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<td></td>
<td>mostly related to speech, diplopia, limited use of left hand, and</td>
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<td></td>
<td>incomplete healing of fractured right leg.</td>
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</table>
scores and electroencephalogram results. Conversely, no such correlating improvement could be demonstrated among the same factors recorded for Patient A. While his electroencephalogram showed marked improvement, his clinical picture and Glasgow Coma Scale scores did not.

Despite the apparent dissimilarities during the patients' hospitalizations, both responded well to intensive rehabilitation therapy. Patient B required 11 more days at the rehabilitation center than did Patient A. However, after their discharges, both patients were able to function at near normal levels.

Table 4 contains information about the patients' biochemical data collected during the research study. A review of the data reveals some instability in the blood pH of Patient B, with a tendency toward alkalinity. This situation may have been induced by deliberately manipulating the patient's ventilatory support system in an attempt to reduce cerebral edema. While other specific elements of the biochemical data showed sporadic fluctuations, B's blood pH was the only value which did not appear to return to within normal limits shortly after becoming known.

Biophysical data from both patients is summarized in Table 5. The data once again depict that Patient B experienced a less stable hospital course than Patient A. Of particular note is Patient B's consistently-elevated temperature and pulse. Although these elevations in and of themselves bear limited significance, taken in the context of the total patient picture they become more meaningful.
### Table 4

**Biochemical Data**

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<th>PO₂</th>
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<th>K⁺</th>
<th>Cl⁻</th>
<th>PH</th>
<th>PCO₂</th>
<th>PO₂</th>
<th>Na⁺</th>
<th>K⁺</th>
<th>Cl⁻</th>
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<tr>
<td><strong>ADMISSION DAY</strong></td>
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### Table 5

**Biophysical Data**

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<tr>
<th>Patient</th>
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<th>Pulse</th>
<th>Respirations</th>
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<td>Mean</td>
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<td>A</td>
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</tr>
<tr>
<td>B</td>
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<td>102.3 (R)</td>
<td>--</td>
<td>120</td>
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* ET tube--hand resuscitated.
Data tabulated on pupil size and reactivity is found in Appendix G. Whereas Patient A's left and right eyes demonstrated a consistent reactivity to light, Patient B's pupillary reaction was much less predictable. The table depicts that during his early hospitalization, the reactivity of Patient B's left eye was quite unstable. By the end of the study, however, his pupillary response to light was beginning to demonstrate a more stable pattern.

Table 6 shows the patients' Glasgow Coma Scale scores. A copy of the Glasgow Coma Scale has been placed in Appendix B. Both Patients A and B started out in the study with scores at or near the lowest scores possible, 3. Patient B's improvement to GCS scores of 10, with a mean of 9 is certainly more impressive than Patient A's high of 6, and a mean of 3.

Summary

The data obtained from this study were presented descriptively. Case studies of the two patients were discussed. Biophysical and biochemical data as well as Glasgow Coma Scores were presented in the form of tables. The findings of this study were subject to multiple limitations which will be discussed in Chapter 5.

Discussion

Patient A was provided with orienting stimuli by the research staff because he was in the experimental group. On the other hand, Patient B was considered to be a "control" patient which precluded the introduction of any reorienting stimuli by the nursing research
Table 6

Glasgow Coma Scale Scores

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staff. However, uncoached by the researchers, from the very beginning of his hospitalization, Patient B's mother faithfully and vigorously provided a variety of reorienting stimuli herself. She read to him, played taped music, brought pictures and familiar items for him to see and feel, and encouraged his friends to visit. She always spoke to him in encouraging and enthusiastic tones. It was impossible to determine whether her supportive approach was the result of her natural maternal instinct, the experience of having had a previous family member recover from coma, or if there might have been "cross-contamination" from the experimental patient's family. Since both Patients A and B ended up spending several weeks in adjacent rooms on the same intensive care unit, and later in the same room on a basic care unit, the families spent long periods of time waiting in the same lounge area. Information was definitely exchanged between families relative to the sons' nursing care.

As discussed previously, consulting neurosurgeons had predicted a poor prognosis for Patient A when, after several weeks of hospitalization, he remained comatose. In contrast to the above was a statement made later by A's physicians at the rehabilitation center. They said that Patient A progressed "much more quickly" toward independence than they would have ever expected.
Chapter 5

SUMMARY, IMPLICATIONS FOR NURSING AND RECOMMENDATIONS

In this study of two comatose patients an answer was sought to the question, "Can the quality of nursing care for comatose patients be improved by nursing therapy with environmental enrichment and meaningful systematic orienting stimuli given by professional nurse clinicians and the patient's significant others as measured by observable changes in arousal patterns in serial EEGs, levels of arousal as scored on the Glasgow Coma Scale and selected recovery outcome measures? Since this study was a beginning attempt to gather evidence about this problem, no effort was made to draw generalizations or conclusions. The nurse investigators felt that conclusions from data gathered on two patients would be inappropriate.

In Chapter 4 the findings on the two patients were presented and described. In Chapter 5 the summary of the study includes a brief summary of the findings, additional limitations of the study, and outcomes of the study in the form of questions raised. Implications for nursing and recommendations for further study are presented.

Summary

The findings of this study on the effect of nursing care on two comatose patients are briefly described in the following paragraphs. Again, no attempt should be made to generalize these findings
beyond the study sample. This study was conducted on the intensive care units of a 538-bed university medical center. The nurse investigators included a neurological nurse specialist and two nurse clinicians assisted by a research assistant who performed the clinical EEGs.

In an attempt to find initial evidence to answer the question posed, one patient was admitted to the study as an experimental patient and another to the control group. While the control patient received routine care, the experimental patient received systematic orienting stimuli as described in Chapters 1 and 3. Both patients were placed on continuous EEG monitoring. Both patients had full 10-montage EEGs at the beginning of the study and on the final study day. Both patients had 3-montage EEGs daily for 80 hours following the initial EEG. Although not in the original overall plan of the study, the experimental patient's family were taught to do systematic orienting stimuli and continued to provide stimuli to this patient over the entire course of his coma which lasted a total of 37 days from the initial loss of consciousness.

**Brief Summary of Findings**

As described in Chapter 4 both of the young male patients were comatose as a result of vehicular trauma. Both were part of a well organized nuclear family who were highly involved in the care and support of the patient. Both patients were given up by health care personnel between week two and week three. Their chances for survival were described as minimal to none. The prognosis for survival with functional capacity was "zilch."
At first glance, when the patients were initially admitted to the study, the injuries appeared similar. However, the progression of time showed dissimilarities in the severity of the neurological damage, i.e., the damage that could be assessed by technological means. Patient A, the clinical trial (experimental) patient, sustained diffuse cerebral edema. His major pathological response was decerebration to pain. His non-neurological injuries included open comminuted fracture of the right tibia and fibula and a fractured right wrist. He developed pneumonia after about 10 days' hospitalization.

In contrast, Patient B, the clinical comparison (control) patient, sustained a diffuse basilar skull fracture, cerebral edema and subarachnoid hemorrhage. His intracranial pressure was elevated intermittently for several days and an intraventricular monitor was placed. As time progressed, the cerebral ventricles became enlarged. His major pathological responses were decerebration to pain, a wandering right eye, bilateral Babinski and dependence on ventilatory assistance. Patient B's non-neurological injuries included a mandibular fracture with missing teeth, open comminuted fracture of the left femur, and considerable periechymosis of the left eye. Although this patient did not receive care from the research personnel, as outlined previously in Chapter 4 his mother provided systematic orienting stimuli similar to that provided to the experimental patient for the duration of his coma, 32 days from initial loss of consciousness. The orienting stimuli provided by this patient's family was virtually indistinguishable from that provided to the clinical trial patient.
The clinical course of Patient B was less stable than that of Patient A even though Patient A developed pneumonia. The instability of Patient B's clinical course may have been attributed to fluctuations in intracranial pressure, fluctuations in blood pH, and alterations in fluid and electrolyte balance, although the latter were not profound.

The EEGs of Patient B showed a predominance of delta or slow wave activity with occasional alpha and theta rhythms and rare beta activity, definitely not a normal pattern. Patient A's EEGs progressed from a predominant pattern of slow wave activity with occasional alpha and beta to a nearly normal pattern on day 14. Contrary to findings by previous investigators (Muderspach; Swanson, 1980), the EEGs of Patient A were not reflected in his clinical status. Although diagnosed by the neurologist as having a nearly normal EEG on the final day of the study (day 14), the patient was clinically unresponsive except to pain and had GCS scores of 3. Overall the GCS scores of Patient B were better than those of Patient A, which raised some questions as to the etiology of the coma of Patient A. As previously noted this patient had ingested Valium prior to his accident. Although friends of the patient reported that he had taken 40 mg., the patient later stated he had taken 120 mg. Thus the ingestion of an unknown amount of Valium was an uncontrolled confounding variable.

**Findings Related to the Research Question**

In the two patients sampled no effect of nursing therapy was noted on the patients' continuous EEGs that could not be attributed
to artifact. Serial EEGs showed no improvement that could not be attributed to time alone. The clinical status of Patient A on a day-by-day basis showed no improvement in relationship to the systematic orienting stimuli that could not be attributed to the passage of time and the reduction of cerebral edema. In contrast to these findings, Buerger (1964) observed both behavioral and physiological changes within five minutes of delivering auditory stimulation to a comatose patient.

The most important finding of this study was that the patients, both of whom received orienting stimuli of a similar nature, contrary to the original study design, survived with near normal to normal functional capacity with the exception that there were residual speech impediments and loss of fine motor coordination in both patients and loss of gross motor function in Patient B's left arm. When compared to the findings of major investigators in the field of coma as described in the review of the literature (Jennet; Teasdale, 1977; Jennet; Bond, 1975), 95 to 99 percent of the patients with stage 3 to 4 initial coma, prolonged coma over 14 days, 99 percent either died or survived in a vegetative state. Including the four patients previously studied for this project, all of whom received orienting stimuli, four of six patients (66%) survived prolonged coma. Three of these patients (50%) were functioning at near normal capacity at least six months after hospital discharge. Therefore, patients who have received orienting stimuli in connection with the current study apparently survived better than could be expected when compared to the findings and statistics reported by other investigators.
Outcomes

Although the size of the sample prohibited drawing conclusions from the data, several outcomes of the study were noted which had a major impact on the overall study. These outcomes were enumerated in the following paragraphs.

1. Two patients with initial GCS scores of 3 to 4 and prolonged coma beyond 14 days survived with near normal functioning after having received orienting stimuli beyond that which is routinely provided patients in the intensive care unit. These findings indicated to the nurse investigators that there may be a relationship between nursing therapy (especially environmental enrichment) and recovery outcomes in comatose patients. Certainly, the findings suggested that this problem was a very important one for further study. Even though minute-by-minute changes in the EEG or GCS scores may not be detectable after the provision of nursing therapy and systematic orienting stimuli, there may be a positive effect on recovery outcome.

2. The problem which occurred with overlap in the clinical trial (experimental) and clinical comparison (control) patients' care, as described previously in Chapter 4, made it obvious that a different sampling technique was needed for admitting patients to the study. The family of patients in the control group should never be placed in a situation where they could observe the care of the clinical trial (experimental) patient or meet the clinical trial (experimental) patient's family.

3. The ethical dilemmas inherent in this study became more pronounced and additional questions were raised. To the original
ethical dilemma of whether or not one should place patients in a control group were added the questions of investigator/observer responsibility relative to the quality of basic patient care delivered and relative to the content of conversation in the presence of the comatose patient. For example, nursing therapy and orienting stimuli in the definitions used for this study included getting the patient up in a chair. Patient A was clinically stable enough to have been placed in a chair by day 5 but in actuality he did not get out of bed into a chair until day 46. Should the nursing therapy have been more aggressive?

Likewise, the unanswerable question as to what the unconscious mind actually records created difficulty in both the psychological and spiritual aspects of patient care. In clinical research, the participant observer/nurse investigator becomes involved in the patient care and cares for both the family and the patient. Did this caring communicate itself to the unconscious patient, unintentionally fostering a dependent relationship between the patient and the participant observer? Was there attachment and bonding with a resultant dependency? Also, in the course of conversation and care what values and attitudes of the investigators were transmitted to the patient and the family?

4. Problems with intracranial pressure were noted which raised additional questions during the study. Traditionally it has been believed that suctioning, coughing, head rotation, neck flexion and a supine or Trendelenberg position increased intracranial pressure (ICP). What effect, if any, do these therapies have on the receptivity of the patient to reorienting stimuli, especially if the intracranial pressure
is already elevated? What effect, if any, do these therapies have on the patient's eventual level of recovery? Could it be that other interventions such as talking with or touching the patient may also increase intracranial pressure? What effect would these otherwise normal occurrences have on an already increased ICP? What effect could anxiety communicated through the family's voices have on an elevated ICP? In the assessment of risk/benefit ratio the investigators believed there was no additional risk to the patients other than the risk posed by normal, routine care. One outcome of this study was to raise the question: Do all types of routine nursing care result in increased ICP in patients whose ICP is elevated? If so, what harm can be expected?

Limitations

Several limitations, both expected and unexpected, were apparent as the research study progressed. In addition to limitations previously discussed, other limitations were described in the following paragraphs.

Geographical placement of patients within the medical center. The initial concern was that by placing patients on different types of intensive care or non-intensive care units the likelihood of patients receiving similar nursing care would be decreased. In this study differences in levels of care were observed by the research staff as patients were transferred between units. Patient A was transferred twice: from one intensive care unit to another and finally to a basic
Patient B was transferred only once, when he progressed from an intensive care unit to a basic care unit. While there were expected differences between intensive care and nonintensive care units, the focus, vigor, and intensity of nursing care between the two ICUs on which Patient A was placed showed some marked variations as well.

Of major consequence to this study was the fact that both Patient A and Patient B spent a major portion of their hospitalization in adjacent rooms on the same ICU. Because their families spent long periods of time waiting in the same waiting room, the way was paved for information to be shared by the families about their sons' nursing care. This definitely influenced the nature of visitations by the control patient's family.

**Care of different medical and surgical staff.** Both patients in this study suffered from serious injuries, including head trauma. Although neurosurgical consultation was requested for both patients, only Patient B received the benefit of regular neurosurgical follow-up, perhaps because he was monitored with an intracranial pressure device.

**Care of different nurses.** Nursing care could be delivered in as many different ways as the nurses' personalities, philosophies, and education could be described. Some nurses just seemed to naturally talk to the comatose patients; others did not. The influence of the presence of the research staff on nurse-patient communication was not assessable.
Presence or absence of family and need/desire on the part of the family to provide orienting stimuli. Both Patients A and B received regular visits from their mothers. The mother of Patient A needed considerable coaching and support from the research staff before she felt comfortable providing orienting stimuli for her son. Even then her attempts were often punctuated with silent pauses and delivered with timidly and uncertainty. On the other hand, Patient B's mother received no coaching from the research staff. Her manner of presenting orienting stimuli was more spontaneous, forceful, and continuous.

The fathers of A and B were both alive but neither visited their sons during hospitalization. While A had had siblings visiting him frequently, B did not. Patient B, on the other hand, received visits from a large peer group. Visits by Patient A's peer group were severely limited by family request.

Extent of post coma complication. Following the initial traumatic insult, both patients developed complications during their hospitalizations. Patient A developed pneumonia and Patient B developed increased intracranial pressure. It was not known to what extent these complications may have interfered with each patient's receptivity to orienting stimuli and to his overall prognosis.

Extent and existence of precoma dysfunctions. The families of Patients A and B denied the existence of any precoma dysfunction. Based on this information, previous dysfunction was not considered a limiting factor for either patient in this study.
Precoma cognitive abilities and psychological state, including overwhelming recent stress or loss. Patient A had experienced the recent stress of marital separation and impending divorce prior to his traumatic incident. His family members commented that as a result he had appeared depressed and had expressed marked concern about the potential decreased contact he would have with his two-year-old son. The effect of the patient's precoma depression on his overall desire to live and to recover from coma was not known.

Patient B's mother admitted that her son was academically slow. It was not known to what degree variations in precoma intellectual function might have later influenced the ability of the comatose patient to receive stimuli and to recover.

History of smoking and drug abuse. Family historians denied the use of tobacco by either Patient A or B. Until Patient A awakened from coma the only information available about his use of drugs was a statement made by his fiancée. She claimed he had taken 40 mg. of Valium just prior to his accident. Several months after regaining consciousness, A admitted to a long personal history of both drug and narcotic abuse. The overall effect of drug abuse may have exerted unidentifiable influences on the patient's recovery.

Inexperience of the EEG technician in recording EEGs. Under the subdued and quiet conditions of the EEG lab, the novice technician for this research project capably developed skill at recording EEGs. However, the noisy environment of the ICU and its frequent interruptions
produced a set of variables which were less easily dealt with. The effect of the resultant graphs marred with artifacts on the neurologist's scoring of EEGs was unknown.

**Inability to force blind scoring of the serial EEGs.** None of the EEGs were subjected to blind scoring. Successive EEGs were often scored together as a "batch" long after they had been recorded. The information about the patients' progress was often available to the neurologist before he scored. These factors may have influenced the EEG findings.

**Equipment limitations.** A Beckman portable EEG/polygraph was used to record the electroencephalograms. Since the machine belonged to the medical center EEG lab, it was not always available to the research staff when needed.

**Inability to collect data for more than a three-month period.** Because of personal obligations, this member of the research staff was unable to collect data for more than a three-month period. Compounding this preset limitation to sample size was the fact that patients who met the sample criteria were unavailable during one month of that time.

**Influence of the presence of researchers.** It was impossible to both measure and control the influence that the presence of research staff had on nursing personnel, their attitudes, behaviors and patient care. Most of the nurses expressed an interest in the study and thus may have intensified their efforts to cooperate and provide excellent
patient care. Others may have viewed the researchers as threatening, a factor which may have had a potentially negative effect on patient care.

**Implications for Nursing**

The practice of nursing in the clinical setting is the meeting place of nursing educators and nursing administrators. Since each of these groups exerts a unique influence in determining clinical nursing practice, implications which are representative of their individual domains are discussed separately in the paragraphs below.

**Implications for Nursing Educators**

Medicine has devoted much time and energy toward refining the medical management and monitoring of comatose patients. Many studies were conducted to research methods of determining prognoses in an attempt to treat comatose patients by triage. Contrasting the efforts of medicine with the availability of nursing research, the latter is alarmingly scarce. While the results of this research project were inconclusive, they were encouraging enough to warrant the introduction of orienting stimuli into the nursing care of comatose patients. Carefully conducted and carefully researched, such a program may not only contribute toward nursing's unique body of knowledge, it may also have a very direct and measurable impact on the lives of all comatose patients, not just a promising few.

A second implication related to the concept is that hearing is the last of the senses which becomes dulled in the unconscious or
dying patient. That there are potentially enduring impressions left on the comatose patient by the spoken word brings both encouragement and caution. The element of encouragement was alluded to in the previous paragraph. The element of caution urged that very careful consideration be given to what is said within earshot of the comatose patient.

**Implications for Nursing Administrators**

Since nursing administrators are responsible for defining standards for clinical nursing, they must grapple with the issue of "practicality" versus "idealism." To successfully accomplish this task administrators must be aware of what kind of nursing care is delivered on the units. Are nurses more interested in providing technical care than in providing psychological and emotional care? What is their attitude toward comatose patients and their families? Are there enough professional nurses providing both intensive and rehabilitative care to brain-injured patients so that environmental enrichment will be guaranteed? Would support groups or inservice programs enhance the demonstration of caring toward the unresponsive patient?

Similar questions must be asked about how nursing administrators care for their staff. If nurses are overly fatigued from working double shifts or a prolonged period of night shifts, can they provide adequate care for patients who require an enriched environment? Is there adequate role modeling so that nurses are comfortable with their role as patient advocates?
Care of the comatose patient touches many aspects of the nursing profession. In this section, questions regarding some of the implications for nursing educators and nursing administrators were raised.

**Recommendations**

Conducted as a pilot study, this research project lacked adequate controls and number of patients to support any generalizable conclusions. It is therefore recommended that further studies of a similar nature be conducted including greater numbers of patients. In addition, the EEGs should be scored blind and within 24 hours of the time each was done. By making this information immediately available to the attending physician, the results may be clinically useful as well as statistically informational.

If experimental and control patients are studied concurrently and if they are located in close proximity within the same institution, the likelihood of their families intermingling and sharing information regarding medical management and nursing care is increased. When patients are designated as "controls" in a study of this nature, consideration must be given to insure against such "cross-contamination" of the patient's significant others.

Researchers Jennett, Teasdale, and others have grappled with the issue of placing any comatose patients in a control group.

An ethical problem is perceived by many clinicians because of the high mortality rate of this condition, and of its predominant occurrence in young patients. This might be regarded as emotional rather than ethical—but it is a fact that doctors faced with this condition frequently consider that every
possible measure must be used which might assist recovery, even if the efficacy of some of these methods is unproven. Doubts about the ethics of controlled trials for conditions associated with a high mortality have recently been expressed. (Jennett; Teasdale; Fry; Braakman; Minderhoud; Heiden; Kurze, 1980, p. 291)

Bleak as they are, statistics describing the prognoses and outcomes of comatose patients who did not receive orienting stimuli do abound. To swell this collection of statistical hopelessness merely to preserve the scientific merit of a study seems unjustifiable. From a practical, realistic and ethical point of view, it is recommended that control patients not be used in subsequent studies of similar nature.

Hopefully, the recommendations presented in this chapter provided some practical suggestions for improving the method of conducting similar research studies. It is also hoped that some philosophical insights were provided for guiding future researchers.
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APPENDIX A

APPROVAL FROM COMMITTEE ON HUMAN STUDIES
September 9, 1980

Evelyn Elwell, D.N. Sc.
School of Nursing
Loma Linda University
Loma Linda, CA. 92350

Dear Dr. Elwell:

Your proposal for a study entitled "Polysomnographic Patterns in Neurologic Dysfunction" was reviewed by the Committee on Human Studies of Loma Linda University at its regular meeting held on August 13, 1980.

The actions of the Committee are as follows:

The subjects are at no additional risk.
The protocol is approved.

If there are any modifications to the proposed research protocol or consent form, or problems arising from the study, please notify the Committee in writing of these changes or problems. If you have questions, please feel free to contact us.

You will be asked to provide a progress report on this study in one year indicating the number of subjects enrolled.

Best wishes for success in this project.

Sincerely yours,

[Signature]

Bruce Wilcox, PhD
Chairman, 1979-80
Committee on Human Studies

BW:aj
APPENDIX B

GLASGOW COMA SCALE
The Glasgow Coma Scale, which is based upon eye opening, verbal and motor responses, is a practical means of monitoring changes in level of consciousness. If each response on the scale is given a number (high for normal and low for impaired responses), the responsiveness of the patient can be expressed by summation of the figure. The lowest score is 3, the highest is 15.

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TOTAL 3-15
APPENDIX C

DATA COLLECTION TOOL
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APPENDIX D

PHYSICIAN CONSENT FORM
As nurses interested in designing nursing interventions to improve the quality of nursing care we are proposing to investigate the effects of a program of orienting stimuli provided to comatose patients. We would like to determine whether such nursing interventions result in an arousal EEG pattern and whether REM sleep can be "reactivated" in comatose patients. The overall goal of this study is to determine if planned nursing intervention can hasten brain repair by "reactivating" normal sleep wakefulness patterns.

CRITERIA FOR SELECTION OF SAMPLE

The following patients will NOT be studied:

1. Patients with acute drug or metabolic coma with the expectation of rapid reversal or extended reversal of the coma.

2. Patients above 70 years of age.

3. Patients whose clinical status is unstable (e.g., patients who show signs and symptoms of rapidly increasing intracranial pressure will not be studied).

4. Patients with a history of diencephalic pathology, malignant hypertension, severe systemic disease, epilepsy, serious prior head injuries, previous brain surgery, or a temperature elevation above 104°F at the initiation of the study.

5. Patients who meet the criteria for irreversible coma (electrocerebral silence, brain death).

6. Patients with pre or postoperative malignant brain tumors which have infiltrated or severed areas believed to contain RAS pathways or a definitive diagnosis of destruction in the region of the locus coeruleus and raphe system nuclei of the brain stem.

7. Patients with identifiable "locked in" syndrome will be removed from the study unless it would be detrimental to the patient in the physician's opinion to do so.

PROCEDURE

Informed consent of the next of kin of the comatose patient will be obtained as soon as possible after admission or onset of coma. The patient will then be placed on the polygraphic recorder for 36 consecutive hours.
Of the patients who remain comatose over 76 hours half will be provided a planned program of reorienting stimuli and nursing therapy by the neurological nurse specialist and nurse researchers. The reorienting stimuli will include information about the patient's family; current events; orientation to person, place, events, and time; and information about things of particular interest to each individual patient. Some of this information will be conveyed by tape recordings played through patient earphones. Other nursing therapies will include use of touch, conversation, and ROM exercises. Biographic and clinical data including vital signs, and neurological vital signs will be collected on each patient. 

T4 and Serum Dopamine levels will be determined daily by using blood previously drawn from the patient as ordered by the physician for other clinical purposes. The arteriosonde will be used to obtain continuous blood pressures. YSI rectal probe will be used to obtain continuous temperatures. No venipunctures or insertion of needles will be done in connection with this study unless separate specific permission is obtained from the physician.

"I have read the proposed research and hereby consent to permit Evelyn L. Elwell, D.N.Sc., R.N. and Annette M. Ross, M.S., R.N., of the Loma Linda University School of Nursing to include my patients in their research study as described in the above paragraphs, and in witness thereof I have signed this consent. I understand that the patients' privacy will be protected and that I am free to withdraw my permission at any time without disadvantage to the patient. I understand that Approval was obtained from the Committee on Human Studies prior to any data collection and that the study is reviewed annually for renewed approval."

______________________________
Signed

______________________________
Signature of Witness

______________________________
Date
APPENDIX E

CONSENT FORM--CLINICAL TRIAL GROUP
CONSENT FORM - CLINICAL TRIAL GROUP

I have been told that the purpose of this study is to find out how deeply the patient is in coma and to try to discover when would be the best time to provide the patient with conversation and activities which might help him/her to be more aroused or to increase his/her level of awareness. The major part of this study will extend over a period of 6-7 days plus 4 hours on the 13th day after the beginning of the study.

I have been told that the following actions or activities will be used when possible to assess if they might help to produce or detect an increase in the patient's alertness:

a. verbal explanations and conversation
b. tapes containing conversation by relatives and friends, music, news and other materials which are meaningful to the patient
c. sitting up in the chair for feedings as condition warrants
d. stimulation of smell and of taste especially at mealtimes with favorite foods and flavors
e. use of gentle pressure and touch and movement of the limbs
f. an initial electroencephalogram and neurologic examination within 24 hours of beginning the study, followed by a continuous polysomnogram and twice daily neurologic examinations. Clinical condition permitting, within 72 hours of the onset of coma, an 80-hour continuous polysomnograph will be made consisting of a 2-4 lead electroencephalogram, electromyogram, and electro-oculograms made with disc cup leads. In addition, a 3 montage clinical portable electroencephalogram will be made each day.

I have been told that two additional blood tests (plasma thyroxine and serum dopamine) will be done on blood drawn by the laboratory for tests already ordered by the patient's physician. This will not involve any additional venipunctures for the patient.

I have been told that I will be informed of any change in the nature of the study or in the procedures described above.
I have been told that this study does not involve any known risks or discomforts to the patient. No electricity passes to the patient and no needles are used to obtain electroencephalographs or polysomnographs unless ordered by the physician for purposes other than this study.

I have been told that the potential benefits of the study to a comatose patient are that:

a. the activities and orienting stimuli may increase their level of awareness which may be detectable on the polysomnograph.

b. during the initial recording and the 80 hours of subsequent recording, a minimum of 2 electroencephalogram channels will be continuously visible to the physicians and other medical/nursing personnel.

c. a minimum of two clinical electroencephalograms will be done, without charge, the results of which will be available to the patient's physician.

d. extra attention to the comatose patient will be provided during the hours of the study, during neurologic exams, and polysomnograms done in connection with the study.

e. their temperature and blood pressure will be monitored automatically every 30-60 minutes.

Also, this study may benefit society by contributing to our knowledge about comatose patients and about the kinds of nursing activities which might help to arouse them.

I have been told that, because of the experimental nature of this study, it is possible that some of these benefits may not occur. I have been told that although this study is classified as experimental the patient is not being experimented upon with untried methods. All of the nursing therapies done with the patient are usual things of everyday living or things routinely done by the nurse or family with comatose patients. EEG's and PSG's are routinely done in clinical laboratories or on nursing care units.

I have been told that refusal to participate in this study will involve no penalties or loss of benefits to which the patient is entitled. I have been
told that if I do not wish the patient to participate in this study, the patient will still receive the usual care as ordered by the primary physician.

I have been told that the information obtained in this study is confidential and that the name and identity of the patient will not be disclosed in any published, unpublished document or photographs.

I have been told that my consent for the patient's participation in this study is voluntary and that I may remove the patient from the study at any time unconditionally and without prejudice to his/her continued care.

I have been told that there will be no additional cost to me, the patient, or third party payer in connection with this study.

To my knowledge the patient _______ has/_______ has not participated in any research study within the past three months. The patient's participation occurred on __/__/____, and involved __________________________

__________________________________________________________

I acknowledge that I have read the contents of this consent form and have listened to the verbal explanation of the investigator.
Study Title: Nursing Therapy with Comatose Patients

My questions concerning this study have been answered to my satisfaction, and I understand that I may call __________________ at ______________________ if I have any additional questions or concerns about my participation in this study. I have been given a copy of this consent form.

________________________________________
Signature       Next-of-Kin          Date

________________________________________
Witness
I certify that I have reviewed the contents of this form with the person signing above who, in my opinion, understood the explanation. I have explained the known side effects and benefits of the study. Any significant change in the nature of the study from that described above will be fully explained to the person signing above.

<table>
<thead>
<tr>
<th>Investigator's signature</th>
<th>Telephone number</th>
<th>Date</th>
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</table>

For all in-patient studies, to insure that patients receive coordinated care from the investigators and the Primary Physician, the Primary Physician is to sign this form as indicating he has knowledge of the research study.

Signature of Primary Physician

Consulting Physician

For all in-patient studies, to insure that patients receive coordinated care from the investigators and from the nursing staff on the unit, the head nurse and the director of the module are to sign this form as indicating that they have knowledge of the research study.

Signature of Head Nurse

Signature of Director of Nursing Department
APPENDIX F

CONSENT FORM--CLINICAL GROUP
CONSENT FORM - CLINICAL GROUP

I have been told that the purpose of this study is to find out how deeply the patient is in coma and to try to discover when would be the best time to provide the patient with conversation and activities which might help him/her to be more aroused or to increase his/her level of awareness. The major part of this study will extend over a period of 5-7 days plus 4 hours on the 13th day after the beginning of the study.

I have been told that the following actions will be used to assess if they might help to detect an increase in the patient's alertness or a decrease in the level of coma:

a. an initial electroencephalogram and neurologic examination within 24 hours of beginning the study,

b. followed by a continuous polysomnogram,

c. twice daily neurologic examinations,

d. clinical condition permitting, within 72 hours of the onset of coma, an 80-hour continuous polysomnograph will be made consisting of a 2-4 lead electroencephalogram, 2 lead electromyograms, and 2 lead electro-oculograms made with disc cup leads,

e. at least a 3 montage clinical portable electroencephalogram will be made each day.

I have been told that two additional blood tests (plasma thyroxine and serum dopamine) will be done on blood drawn by the laboratory for tests already ordered by the patient's physician. This will not involve any additional veni-punctures for the patient.

I have been told that I will be informed of any change in the nature of the study or in the procedures described above.

I have been told that this study does not involve any known risks or discomforts to the patient. No electricity passes to the patient and no needles are used to obtain electroencephalographs or polysomnographs unless ordered by the physician for purposes other than this study.
I have been told that the potential benefits of the study to a comatose patient are that:

a. the actions described (especially the neurological exams) may help to increase their level of awareness which may be detectable on the polysomnograph.

b. during the initial recording and the 80 hours of subsequent recording, a minimum of 2 electroencephalogram channels will be continuously visible to the physicians and other medical/nursing personnel.

c. a minimum of two clinical electroencephalograms will be done, without charge, the results of which will be available to the patient's physician.

d. their temperature and blood pressure will be monitored automatically every 30-60 minutes.

Also, this study may benefit society by contributing to our knowledge about comatose patients and about the kinds of nursing activities which might help to arouse them.

I have been told that, because of the experimental nature of this study, it is possible that some of these benefits may not occur. I have been told that although this study is classified as experimental the patient is not being experimented upon with untried methods. The neurologic examinations are routinely done by the nurse with comatose patients. Electroencephalograms and polysomnograms are routinely done in clinical laboratories or on nursing care units.

I have been told that refusal to participate in this study will involve no penalties or loss of benefits to which the patient is entitled. I have been told that if I do not wish the patient to participate in this study, the patient will still receive the usual care as ordered by the primary physician.

I have been told that the information obtained in this study is confidential and that the name and identity of the patient will not be disclosed in any published, unpublished document or photographs.
I have been told that my consent for the patient's participation in this study is voluntary and that I may remove the patient from the study at any time unconditionally and without prejudice to his/her continued care.

I have been told that there will be no additional cost to me, the patient, or third party payer in connection with this study.

To my knowledge the patient ____ has/____ has not participated in any research study within the past three months. The patient's participation occurred on ____/____/____, and involved________________________________________________________________________

I acknowledge that I have read the contents of this consent form and have listened to the verbal explanation of the investigator.
Study Title: Nursing Therapy with Comatose Patients

My questions concerning this study have been answered to my satisfaction, and I understand that I may call __________ at __________ if I have any additional questions or concerns about my participation in this study. I have been given a copy of this consent form.

______________________________  ________________________________  _________________________
Signature                  Next-of-Kin                   Date

______________________________
Witness
I certify that I have reviewed the contents of this form with the person signing above who, in my opinion, understood the explanation. I have explained the known side effects and benefits of the study. Any significant change in the nature of the study from that described above will be fully explained to the person signing above.

<table>
<thead>
<tr>
<th>Investigator's signature</th>
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<th>Date</th>
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For all in-patient studies, to insure that patients receive coordinated care from the investigators and the Primary Physician, the Primary Physician is to sign this form as indicating he has knowledge of the research study.

Signature of Primary Physician

Consulting Physician

For all in-patient studies, to insure that patients receive coordinated care from the investigators and from the nursing staff on the unit, the head nurse and the director of the module are to sign this form as indicating that they have knowledge of the research study.

Signature of Head Nurse

Signature of Director of Nursing Department
APPENDIX G

Table 7
### Table 7

**Pupil Size and Reactivity**

| Patient | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| **Adm. Day** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **A** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **B** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **Day 1** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **A** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **B** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **Day 2** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **A** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **B** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **Day 3** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **A** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **B** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **Final Study Day** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **A** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **B** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

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APPENDIX H

Figure 2
Adapted from Bennett; Hughes; Korein; Merlis; Suter, 1976, p. 241.

Figure 2
International (10-20) Electrode Placement
APPENDIX I

Table 8
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<th>C</th>
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