COMPENSATORY CONTROLLED OXYGENATION AND LEVEL OF CONSCIOUSNESS

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We hereby recommend that the thesis prepared under our supervision by Diane Elizabeth Schull, B.S.N., R.N. entitled Compensatory Controlled Oxygenation and Level of Consciousness

be accepted as fulfilling this part of the requirements for the Degree of Master of Science.

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DEDICATION

To my beloved grandfather, Angelo Hector Scarpa, who taught me the value of history, spelling, and a scrupulous pinochle game.

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CHAPTER I

INTRODUCTION

Trauma is the most common cause of death between the ages of eighteen and thirty-five. The National Safety Council reveals that 70 percent of three million motor vehicle injuries sustained yearly result in craniocerebral trauma. Neurological and psychosocial follow-up studies reveal that many recoveries have significant residual neurological deficits.

Traumatic craniocerebral injury is the result of primary destructive lesions occurring above (supratentorial) or below (infratentorial) the tentorium cerebelli. The primary focus of treatment is to prevent brain lesions caused by circulatory impairment, ventilatory insufficiency, and cerebral edema. Fifty percent of patients with traumatic head injury have significant hypoxemia and this ventilatory insufficiency is the most common cause of impaired consciousness. Control cannot be exercised over the primary destructive lesion, however, experimental evidence suggests that secondary brain lesions can be minimized through expert nursing and medical interventions. Mechanical ventilation is often initiated to correct the ventilatory insufficiency. The response to the ventilatory regimen is measured by monitoring those clinical parameters and laboratory studies reflecting the degree of oxygenation. A problem in the treatment of patients with traumatic head injury is the evaluation of the degree of oxygenation and its effect on the level of consciousness.

Statement of Problem

The question to be answered by this study was: What was the correlation of compensatory controlled oxygenation with the level of consciousness in patients with traumatic head injury?

Purposes

From the statement of the above problem, the following purposes were:

1. To correlate the degree of oxygenation with the clinical parameters of blood pressure, pulse pressure, pulse, and temperature in patients with a supratentorial lesion

2. To correlate the degree of oxygenation with the clinical parameters of blood pressure, pulse pressure, pulse, and temperature in patients with an infratentorial lesion

3. To compare the mechanical mechanisms of ventilation on the degree of oxygenation in patients with a supratentorial lesion

4. To compare the mechanical mechanisms of ventilation on the degree of oxygenation in patients with an infratentorial lesion

5. To correlate the level of consciousness with the clinical parameters of blood pressure, pulse pressure, pulse, and temperature in patients with a supratentorial lesion

6. To correlate the level of consciousness with the clinical parameters of blood pressure, pulse pressure, pulse, and temperature in patients with an infratentorial lesion

7. To compare the mechanical mechanisms of ventilation on the level of consciousness in patients with a supratentorial lesion

8. To compare the mechanical mechanisms of ventilation on the level of consciousness in patients with an infratentorial lesion

9. To compare the relationship of degree of oxygenation and level of consciousness between patients with a supratentorial lesion and patients with an infratentorial lesion

Theoretical Framework

High Level wellness is a concept defined as an integrated method of functioning which is oriented toward maximizing the potential of which the individual is capable. It requires that the individual maintain a continuum of balance and purposeful direction within the environment where he is functioning (Dunn 1973). The author of this theory states that "high level wellness" involves several concepts. First of all, it is a direction in progress forward and upward toward a higher potential of functioning; second, it is open-ended and ever-expanding, with its challenge to live at a fuller potential; and third, it is the integration of the total individual--his body, his mind, his spirit--in the functioning process.

The process of planned nursing care that is individualized, holistic, and directed toward high level wellness may be achieved by the utilization of a systems approach. As Banathy (1968) states in his preface to Instructional Systems,

> In the systems approach we have a methodology, the use of which empowers us to explore and manage complex entities. In fact, we may have here something by which we cannot only cope with our environment, but also be able to shape and master it and make change work for us (p. iii-iv).

With the systems approach, the organization of the whole is considered by determining how the parts interact to make the whole. Systems theory is concerned with purpose, process, and content. Purpose gives direction to the system and process determines the means by which the system accomplishes the purpose. The nature of the process suggests the component parts of the content of the system.

Examination of the effects of compensatory controlled oxygenation upon the level of consciousness is facilitated through the use of the homeodynamic systems model. The homeodynamic systems model is a means of organizing data to create a holistic approach to planning nursing care. The homeodynamic model is a conceptual organization of ideas, theories, and concepts. Its purpose is to help the nurse develop a frame of reference whereby the interrelatedness of the individual and his universe can be understood. The model proposes a matrix of ideas that symbolize the individual and his environment in their wholeness. It rests on these basic premises:

1. The individual is a system with purpose, process, and content

2. The individual's purpose is self actualized, high level wellness

3. The individual's processes are those that enable and promote the purpose of high level wellness

4. Content is all the factors that make up the processes

5. The individual is homeodynamic in nature

The most important concept of the homeodynamic model is its wholeness. The model depicts the individual as a unified whole having distinctive characteristics that cannot be perceived by looking at the parts. However, a summation of the parts does not add up to a whole. The individual as a whole interacts with the whole environment. Changes taking place in one affect the other. Pattern and organization give individuality to each, and alteration in the organization or pattern are continuous. It demonstrates the individual's struggle to balance the inner forces as he strives to reach maximum potential.

Background and Significance

In the assessment of patients with traumatic head injury, clinical parameters provide the rationale for the institution of therapy and complimentary diagnostic procedures. The pathophysiologic sequel of supratentorial and infratentorial lesions identifies increased intracranial pressure and decreased level of consciousness.

A supratentorial lesion produces intracranial pressure by enlarging and shifting across the brain's midline and compressing the other hemisphere. The lesion extends damage to the diencephalon and midbrain, structures that normally activate or arouse the cerebrum. The supratentorial lesion evokes local and remote tissue reactions that secondarily displace the brain down toward the tentorial incisura, additionally compressing the diencephalon. Two types of infratentorial lesions cause an increased intracranial pressure and decreased level of consciousness. Those located within the brainstem destroy the reticular formation and those located outside the brainstem compress the reticulum. Lesions in the brainstem directly invade and destroy the brainstem central core by impairing the blood supply and producing ischemia, necrosis, or hemorrhage (Plum and Posner 1972).

Increased intracranial pressure is accompanied by a rising systolic blood pressure, a widening pulse pressure, and a slowing pulse (Cushing 1901; Teasdale, Knill-Jones, and Jennett 1974). As valuable as these clinical signs often are, they do not indicate the presence or absence of an intracranial lesion. The patient with traumatic head injury can have progressive neurological deterioration before a change in vital signs is evident.

Deterioration of the level of consciousness is the earliest sign of intracranial pressure (Plum and Posner 1972). Consciousness, defined as the awareness of the self and the environment (Plum and Posner 1972), has two components: (1) the content of mental functions, and (2) the arousal or the wakefulness aspect. The ascending reticular activating system (RAS), which controls wakefulness or arousal, can be activated by almost any type of sensory stimulus which then transmits signals to the cerebral cortex arousing the individual. The sensory input bombards the ascending reticular activating system and maintains the conscious state. A reduction in sensory input results in sleep; an abolition of all sensory input produces coma. Two other sources can activate the RAS: the cerebral cortex and the production of the hormone, epinephrine. The greater the intensity of signals from the activated areas of the cerebral cortex the higher the level of consciousness. If this system with its blood supply or its associated pathways is impaired by an increased intracranial pressure, loss of consciousness results. Full consciousness requires continuous and effective interaction between intact cerebral hemispheres and the ascending reticular activating system.

The level of consciousness is clinically evaluated and categorized by the motor and sensory responses to verbal, tactile, or pain stimuli (Plum and Posner 1972). A decreased motor and sensory response indicates cortical or midbrain compression (Plum and Posner 1972). Changes in pupillary size, equality, and responsiveness indicates impairment of the third, fourth, and sixth cranial nerve nuclei (Meltzner and Frew 1976; Becker 1977). Changes in vital signs reflect hypoxia of the brain stem secondary to decreased perfusion pressure with the intracranial pressure being the greatest in the lower brain stem and medulla (Miller et al. 1977). It becomes apparent that the observation and recording of the vital signs, the level of consciousness, and the pupillary response are important in establishing baseline data so that subsequent changes may be evaluated for appropriate nursing and medical intervention.

In the evaluation of patients with traumatic head injury, respiratory function has prognostic significance and therapeutic implications. Respiration is an integrated function of the brain to control respiratory rate and pattern. Any interruption in cerebral activity by either hemorrhage or elevated intracranial pressure can affect it, and conversely, inadequate ventilation can raise intracranial pressure and lower the level of consciousness (West 1974; Miller 1977).

The maintenance of the highest possible oxygen supply to the brain is of clinical importance. The specialized cortical cells of the brain are most sensitive to oxygen deprivation. Controlled ventilation is considered as a therapeutic measure with the partial pressure of arterial oxygen (PaO2) is less the 75 mm Hg. The decision to institute artificial ventilation is based on assessment of ventilatory drive and blood gas exchange (Pontoppidan et al. 1972; West 1974).

Secondary insults to the brain have an important adverse influence on the outcome from head injury. If these insults can be prevented or reversed, patients with traumatic head injury can make a useful recovery. It is important for the nurse to have adequate parameters with which to assess the degree of oxygenation and its affects on the level of consciousness in an effort to maintain functional life.

Hypotheses

The hypotheses for this study were:

1. There was no relationship between the degree of oxygenation and the clinical parameters

2. There was no relationship between the degree of oxygenation and ventilatory measures

3. There was no relationship between the level of consciousness and the clinical parameters

4. There was no relationship between the level of consciousness and ventilatory measures

5. There was no difference between the degree of oxygenation and the level of consciousness between patients with a supratentorial lesion and patients with an infratentorial lesion

Definition of Terms

The definitions of this study were:

Compensatory controlled oxygenation--the counterbalancing of any defect in the maintenance of oxygenation through the use of mechanical assistance devices during respiratory impairment, insufficiency, or failure. It is measured by the arterial blood gas value, hemoglobin and hematocrit

Level of consciousness--the patient's degree of awareness, as measured by response to verbal, tactile, or pain stimuli

Clinical parameters--an arbitrary constant characterized as blood pressure, pulse pressure, pulse, and temperature

Mechanical mechanisms of ventilation--the process of supplying oxygen to the lungs through intratracheal intubation and dependent upon the inspired oxygen concentration (FiO2) and respiratory rate

Traumatic head injury--an injury produced by an internal and/or external force resulting in either a supratentorial lesion or infratentorial lesion and diagnosed by a physician

Supratentorial lesion--mechanical disruption of cerebral tissue occurring above the dura in the cerebellum and confirmed by skull x-ray and/or computerized axial tomography (CAT Scan)

Infratentorial lesion--mechanical disruption of cerebral tissue occurring below the dura in the cerebellum or brainstem and confirmed by skull x-ray and/or computerized axial tomography (CAT Scan)

Limitations

There was no control over the following variables:

1. The study was conducted by one researcher

2. The differences in intra and inter disciplinary interventions used by an individual nurse, physician, and/or respiratory therapist may influence the neurological and pulmonary status of the patient

3. The predisposition of the patient to iatrogenic disorders

4. There was no baseline respiratory data for the patient prior to hospitalization

5. Medications that were received by the patient during hospitalization may influence the neurological and pulmonary status of the patient

6. The researcher-designed tool was not previously tested for validity and reliability

Delimitations

The delimitations for this study were as follows:

1. Patients were hospitalized following a traumatic head injury

2. Patients had a primary medical diagnosis of a supratentorial lesion or infratentorial lesion confirmed by skull x-ray and/or computerized axial tomography (CAT Scan)

3. Patients were between the ages of 18 and 35

4. Patients were intubated or had tracheostomies

5. All patients were mechanically ventilated for a period of at least four consecutive hours

6. Patients were in an intensive care unit during mechanical ventilation

7. Patients had no diagnosed, non-iatrogenic, cardiopulmonary complications prior to admission and during period of ventilatory assistance

8. The literature reviewed was in the English language

Assumptions

The research was based on the following assumptions:

1. The brain consumes 15-20 percent of total body resting oxygen

2. The brain has a ten second supply of oxygen and no reserve

3. Highly specialized cortical cells of the body are most sensitive to oxygen deprivation

4. The level of consciousness is one of the earliest and most sensitive indicators for detecting neurological deterioration

5. Hemoglobin is the oxygen-carrying pigment of the blood

6. Arterial blood gas studies are indicators of respiratory function

Summary

Chapter I presented the purposes, hypotheses, and significance of the research to be studied. A review of the literature pertaining to traumatic head injury resulting in supratentorial or infratentorial lesion sites; the determinants of the level of consciousness, and the effects of compensatory controlled oxygenation is presented in Chapter II. Chapter III presents a discussion of the research methodology, including a description of the sample and the instrument employed. Chapter IV identifies the findings of the study as well as the statistical analysis and interpretations. Finally, the summary, conclusions, implications, and recommendations are outlined in Chapter V.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

The review of literature is comprised of two major sections. The first section contains a discussion of the physiology, etiology, and measurements of consciousness. The second pertains to compensatory controlled oxygenation, the physiology, and the mechanical mechanisms and measurement of ventilation.

Consciousness

Consciousness is the expression and awareness of an aroused mind (Plum and Posner 1972) with a total complement of integrative functions which adapt and relate man to his environment. Recognized by introspection, or evident through the intercession of motor behavior, consciousness remains difficult to define. Advocates of the concept of centers of consciousness have located this function in the frontal lobes (Jackson 1958) and corpus striatum (Dandy 1946), however the thesis of centers has been discarded (Brain 1958) with emphasis placed on the distinction between function and its anatomical substratum.

The present physiologic concept of consciousness requires a continuous and effective interaction between intact cerebral hemispheres, which contribute to the specific components of consciousness and the physiological activating mechanisms in the upper brainstem called the ascending reticular activating system (ARAS) (Plum and Posner 1972). In order to function effectively, the cerebrum is aroused or activated by caudally placed mechanisms that originate in the thalmus, hypothalmus, midbrain, and upper pons. This arousal mechanism located within the ARAS influences cerebral coritcal activity and the state of consciousness (Plum and Posner 1972).

Anatomically, the ARAS has indistinct boundaries which extend within the central brainstem from the lower medulla to the thalamus, incorporating both small and large neurons. Short and long axons provide interconnections within the formation, endowing it with the property of both slow and rapid conduction. Individual cells extend their dendrites over large areas, creating optimal anatomical opportunities for stimulation by collaterals coming both from many different specific fiber pathways and from adjacent brainstem nuclear masses (Starzl, Taylor, and Magoun 1958; Plum and Posner 1972).

In the thalmus, the ARAS is interspersed among the main sensory nuclei. Morphologically, it includes the septal region, the hypothalmus, and the midbrain tegmentum. The ARAS receives collaterals from and is stimulated by every major somatic and special sensory pathway (Magoun 1963; Moruzzi 1964). Spinothalamic collaterals to the midbrain tegmental reticulum provide a morphological basis for the arousing qualities of noxious stimuli. The cerebral cortex not only is stimulated by the ARAS, but restimulates and modulates the reticulum (Magoun 1963; Foltz and Schmidt 1956; Moruzzi 1964; Plum and Posner 1972). It has been postulated that this is the feedback mechanism by which the forebrain regulates incoming information (Magoun 1963). This feedback mechanism explains why incoming messages of equal intensity but different meaning have profoundly different capacities to arouse. There are close connections between the ARAS and the rhinencephalon, that phylogenetically older and deeper part of the forebrain, which is believed to mediate a large part of both emotional behavior and memory. Dysfunction in those limbic-reticular interrelationships has been implicated to explain the confusion, hallucinations, and distortions of memory and perception that often accompany states of reduced consciousness (Plum and Posner 1972).

It is difficult to subdivide functional areas of the ARAS on morphological grounds because of its diffuse, polysynaptic anatomy (Plum and Posner 1972). As a result, the ARAS is more a physiological than anatomical entity. The caudal extent of the structures critical to consciousness is not exactly known, however the reticular formation of the lower pons and medulla appears to have important influences on certain stages of sleep and on the electroencephalogram (Plum and Posner 1972). Some researchers believe that all cortically directed reticular activity is first mediated through the thalmic reticular nucleus, while others propose more widespread anatomical routes for cortical excitation (Plum and Posner 1972). In either case, large portions of the brainstem neuronal reticulum are involved in the arousal mechanism (Plum and Posner 1972; Locke 1968).

The Etiology of Altered States of Consciousness

The intracranial space is bound by thick bone that is non-distensible and is filled to capacity with non-compressible contents. These can be divided into three fluid compartments, brain tissue water, intravascular blood, and cerebrospinal fluid (CSF). The intracranial space is vented from the supratentorial compartment to the posterior fossa through the foramen magnum to the spinal canal. In addition, intravascular blood and CSF can be expressed into the extracranial vascular system. Thus, the intracranial space contains displaceable fluid in the form of CSF and blood. Cerebrospinal fluid volume is approximately 10 percent of the intracranial volume; values for intracranial blood volume have varied from 2 to 11 percent (Langfitt 1968).

As a mass (or the brain) expands, fluid is expressed from the intracranial space in order to accommodate the mass, and as long as the volume displaced equals the volume added, intracranial pressure (ICP) does not change (Plum and Posner 1972). If the mass continues to expand, however, ICP begins to rise, because the volume of displaceable fluid is finite (Bruce et al. 1973). Furthermore, each additional and equal increment in the volume of the mass produces a larger increase in ICP such that when nearly all displaceable fluid has been eliminated, a slight further increase in volume produces a very large rise in ICP (Bruce et al. 1973). By the same token, when ICP is greatly elevated, a slight reduction in the volume of any one of the intracranial compartments produces a marked fall in ICP (Bruce et al. 1973). Intracranial pressure is also dependent on the rate of expansion of the mass

(Bruce et al. 1973; Plum and Posner 1972). A rapid addition of a small volume causes a larger rise in ICP and brain dysfunction than a much larger mass that expands slowly (Bruce et al. 1973; Marsh, Marshall, and Shapiro 1977; Walt 1977).

The level of consciousness is the most important sign of increased ICP (Plum and Posner 1972). The mechanisms by which neurological disorders cause an increased ICP and an altered level of consciousness are: (1) supratentorial mass lesions, (2) infratentorial, comprehensive, or destructive lesions, and (3) metabolic brain diseases (Plum and Posner 1972). This research studies the first two categories of supratentorial and infratentorial lesions.

Supratentorial lesions cause altered levels of consciousness by directly destroying or replacing the cerebral hemispheres (Vogel 1971). With any large, acute supratentorial space-occupying lesion, the space available for expansion above the tentorium is rapidly filled. Only the subarachnoid space and the lateral ventricles are available as potential extra space and the lateral ventricle on the side of the lesion is narrowed; the hemispheres on that side are pushed across the midline and the basal midline structures (Iwakuma and Brunngraber 1973).

When the limits of this displacement of the brain have been reached, the increasing lesion pushes the nearest supratentorial structures through the incisura tentoria caudally. There is no other direction or orifice through which the cerebral tissue can escape, and the pressure may be sufficient to displace the midbrain below the level of the incisura so that the substantia nigra, the lowest part of which normally lies at the incisural level, may be displaced much below this level. This displacement of the midbrain structures caudally may produce visible elongation and narrowing of the midbrain (Vogel 1971; Iwakuma and Brunngraber 1973). If the supratentorial space-occupying lesion is bilateral, the effects on the brain stem may be bilateral and the uncus on each side is partly herniated or at least pressed down hard against the free edge of the tentorium. This is seen in acute, bilateral subdural hemorrhage, but may occur after extensive coritcal contusions with associated white matter edema. More commonly, the downward pressure on the brain stem is from a predominantly unilateral injury, and the displacement is therefore partly lateral as well as downward; in all severe instances the medial portion of the uncus is driven between the free edge of the tentorium and the lateral margin of the displaced brainstem. This downward movement of the midbrain naturally carries the attendant cerebral arteries in a caudal direction so that the basilar and posterior communicating arteries in particular are placed under tension, and their small branches are probably more severely affected than the parent vessel (Richards and Hoff 1974). The posterior cerebral arteries, the origins of which are also displaced caudally, are severely stretched over the free edge of the tentorium and are often considerably kinked. The pressure on the artery at this point is increased by hippocampal herniation, the herniated brain, in some instances at least, pushing down between the posterior cerebral artery and the brain stem. This stretching and distortion of arterial supply can clearly in itself greatly reduce the lumen of the vessels and if, as seems likely in the stretched vessels, spasm occurs, then the ischemic lesions in the tegmentum and pons, temporal and occipital lobes and posterior thalmus are logically explained. The extensive midbrain hemorrhages often seen with acute supratentorial brain swelling may be or arterial origin (Richards and Hoff 1974); if the stretching of vessels is sufficiently great, small arterioles may actually be town, but a more likely explanation is that the hemorrhages result from venous obstruction from the pressure on the vessels within the upper brain stem after impaction of the uncus into the incisura. In many less severe examples of brain stem bleeding, the hemorrhages are often demonstrably perivenous and in severe instances of massive bleeding, necrotic veins can be demonstrated (Bruce et al. 1973). Edema fluid in the vicinity of the perivenous hemorrhages may also be seen, the neighboring neurons often show degenerative change (Bruce et al. 1973).

Lateral and downward displacement of the brain stem with elongation anteroposteriorly suggest that distortion of the ponto-medullary portion of the brain stem may be responsible for the cardio-respiratory alteration which characterizes some cases of increased intracranial pressure (Bruce et al. 1973). The changes consist of slowing of the pulse rate, increase of pulse pressure, elevation of blood pressure, slowing of respiration, and terminal respiratory arrest (Teasdale 1976). Research has shown that these result from an acute, dynamic, axial brain stem distortion brought about by the descent of the upper brain stem above relatively rigidly fixed medulla and upper cervical cord which cannot shift downwards (Miller et al. 1977; Becker et al. 1977). The resulting distortion interferes with the conductivity of the ponto-medullary centers regulating cardiac and respiratory activity. This reasonable hypothesis might explain the occasional dramatic, sudden death after head injury in which only moderate damage is found above the tentorium with no evidence of damage in the brain stem. In the occasional case of immediate death from falling on to the vertex, a thin line of hemorrhage along the inferior surface of each uncus which has been driven downwards and bruised against the free edge of the tentorium, may be the only evidence of severe, sudden, downward placement of the upper brain stem, which has caused distortion of the lower stem with immediate cardiac or respiratory arrest (Barber and Webster 1974). In some circumstances downward shift of posterior fossa structures occurs, for impaction and actual infarction or hemorrhage of the cerebellar tonsils may result from severe raising of intracranial pressure.

Brain stem hemorrhage and infarction secondary to supratentorial space-occupying lesions of traumatic origin are commonly the fatal lesions in cases in which recovery would occur if surgical intervention had been sufficiently rapid. This applies to extradural hemorrhage in which the brain itself may be little damaged, to some cases of acute and many of chronic subdural hematoma, and to many cases of brain injury in which the supratentorial swelling has been a combination of bleeding around and into the brain with edema around the hemorrhage adding to the supratentorial mass.

Two kinds of infratentorial lesions cause altered levels of consciousness: (1) those located within the brainstem that destroy the ARAS, and (2) those located outside the brainstem that compress its reticulum (Plum and Posner 1972). Infratentorial lesions within the brainstem directly invade and destroy the brainstem central core or impair its blood supply to produce ischemia, necrosis, or hemorrhage. Infratentorial lesions lying outside the brainstem by either direct pressure upon the tegmentum, usually at the pontine level, upward herniation of the cerebellum and midbrain through the tentorial notch, compressing the mesencephalon tegmentum or downward herniation of the cerebellar tonsils through the foramen magnum compressing the medulla (Plum and Posner 1972).

Patients with destructive infratentorial lesions often lose consciousness immediately and the ensuing coma is accompanied by distinctive patterns of respiratory, pupillary, oculovestibular, and motor signs that clearly indicate whether it is the tegmentum of the midbrain, the rostral pons, or the caudal pons that is most severely damaged (Plum and Posner 1972).

Clinical Parameters

There are four aspects to consider in the assessment of a patient with traumatic head injury. These are: (1) the level of consciousness, (2) the motor and sensory response, (3) the pupillary response, and (4) the vital signs. The Glasgow Coma Scale was developed as a tool to evaluate the level of consciousness based upon clearly defined criteria. Three separate aspects of the patient's responsiveness are evaluated: the stimulus required to induce eye opening; the best verbal response; and the best motor response. Each is evaluated independently and according to a well-defined series of responses which indicate increasing degrees of dysfunction (Teasdale and Jennett 1974).

Spontaneous eye opening indicates that arousal mechanisms in the brain stem are active (Plum and Posner 1972). It does not imply awareness. If spontaneous opening is not present, verbal command is followed by painful stimulation, applied by pressure on the fingertips. Once the patient has been roused as fully as possible, speech and motor performance are assessed.

Orientation requires the patient to know who he is, where he is, and the date (Plum and Posner 1972). Conversational exchange short of this is termed confusion.

Inappropriate words refer to intelligible articulation used in an exclamatory, random way. Moaning and groaning constitutes incomprehensible sounds. While the presence of such speech indicates a high degree of integration in the nervous system (Plum and Posner 1972; Teasdald and Jennett 1974), speechlessness may, of course, be the results of reasons other than impaired consciousness such as dysphasia.

To reflect the functional state of the brain as a whole, the best or highest response from any limb is recorded (Plum and Posner 1972; Teasdale 1976; Jennett and Bond 1975). Differences between the response of the two sides indicate focal brain damage. Obeying commands is judged from the response to instructions such as to lift the arm, or protrude the tongue. Reflex grasp responses occur in unconscious patients and asking a patient to squeeze the examiner's hand is not a reliable test. Painful stimulation is applied in a standard way, fingertip pressure being used initially to induce a response, followed by pressure over the supraorbital notch to test for localization. Flexion response may vary between normal and rapid withdrawal and abnormal slow dystonic movements in which the limbs assume stereotyped postures. Extension responses of the upper or lower limbs are abnormal (Becker et al. 1977; Jennett and Bond 1975).

The reliability of the scale has been confirmed (Teasdale, Knill-Jones, and Jennett 1974) and has greatly enhanced the value of routine observations (Teasdale 1975).

The pupillary reactions of constriction and dilatation are controlled by the parasympathetic and sympathetic nerves, respectively. The oculomotor or third cranial nerve includes in its innervation parasympathetic fibers for the sphincter muscle of the iris which normally cause it to contract when light is flashed into the eye--an involuntary response. These fibers originate in the Edinger-Westphal nucleus in the midbrain (Teasdale 1976).

After the oculomotor nerve exits from the brainstem, the nerve passes near the tentorial notch alongside the midbrain. It is the direct pressure, whether from above or below the tentorium, the stretching or displacement imposed on the oculomotor nerve that is responsible for some deviations in pupillary size, equality, and reaction to light. If compression of these fibers is present, unilateral pupillary dilatation results with loss of light reflex response on the same side of the compression, since the sympathetic fibers which produce dilatation are left unopposed. The reverse is true if there is compression of the sympathetic pathways which originate in the hypothalmus and course the brain stem ipsilaterally to the upper three segments of the thoracic cord. The size of pupils in normal individuals varies with the amount of environmental light from approximately 1.5-2.0 mm (near maximal miosis) to 8-9 mm (maximal mydriasis) (Plum and Posner 1972).

Pinpoint and fixed pupils indicate damage to the pons area, midfixed pupils indicate midbrain damage, and dilated and fixed pupils indicate medullary damage (Plum and Posner 1972). The best prognosis is associated with midfixed pupils; the worst prognosis is associated with dilated and fixed pupils. Pupillary dilatation may occur with herniation of the third cranial nerve accompanying herniation of the uncus. The posterior cerebellar artery may be damaged at the same time, resulting in midfixed pupils (Meltzner and Frew 1976).

Vital signs are basic in the assessment of intracranial pressure changes. Investigators have found consistent cardiovascular and respiratory changes in association with increased intracranial pressure. Initially, a transient increase in expired carbon dioxide causes a gradual increase in intracranial pressure, accompanied by decreases in heart rate and respiratory rate and depth. When intracranial pressure reaches a peak, heart rate and respiratory rate and depth increase

(Lloyd 1973). It is found that irregular breathing is highly correlated with injury of the lower part of the brainstem, and, therefore may be indicative of a bad prognosis (North and Jennett 1974).

An increased systolic blood pressure accompanied by a widening pulse pressure classically indicates a rise in intracranial pressure (Cushing 1901; Teasdale, Knill-Jones, and Jennett 1974). Explanation offered for the rise in systolic blood pressure during the compensatory stages include the Cushing reflex (Cushing 1903; Teasdale 1976). Cushing (1903) noted that, as cerebrospinal fluid pressure rises to equal arterial pressure, it gradually compresses the arteries in the cranial vault and slowly cuts off the blood supply to the brain. This causes ischemia of the vasomotor center which triggers a marked rise in arterial pressure. The arterial pressure rises until it is higher than the cerebrospinal fluid pressure with the result that blood resumes its flow into the vessels of the brain to relieve the ischemia. This is a protective reflex for the vital centers of the brain and is one possible explanation for the rise in systolic pressure during the compensatory stage. In the decompensated stage, the blood pressure falls with subsequent death to the patient.

An increase in temperature in a patient with traumatic head injury is initially caused by increased intracranial pressure or damage to the hypothalmus. Hyperthermia increases the metabolism of the brain, which in turn, increases the need for oxygen in the need for oxygen in the brain. With each degree of Centigrade, the need of the brain for oxygen increases 6 to 7 percent (Stoner 1973; Row 1973).

Compensatory Controlled Oxygenation

Oxygenation of the traumatic head injured patient is dependent upon a complex chain of physiologic events. The normal brain consumes 3.3 ml. of oxygen per 100 gm of tissue per minute (Ketz and Schmidt 1948; Ferguson and Gaensler 1968; West 1974). In the adult, if the oxygen consumption of the brain falls to 2.5 ml./100 gm. intellectual impairment and drowsiness occur. Below 2.0 ml./100 gm. the majority of individuals become comatose (Plum and Posner 1960; Ferguson and Gaensler 1968).

Oxygen is used for the aerobic oxidation of glucose with the production of adenosine triphosphate (ATP). Hypoxia of the brain resulting from traumatic head injury leads to depression of the enzymatic-oxidative processes and accumulation of incompletely oxidized products of protein, carbohydrate, and lipid metabolism in cerebral tissue. When the dehydrogenase activity and oxygen utilization of the brain drops 40 to 50 percent of its normal level, brain hypoxia and cerebral edema ensue (West 1974).

The blood stream may fail to deliver a sufficient amount of oxygen to the brain to maintain consciousness for a number of reasons: (1) the cardiac output may be too low. A fall in cardiac output decreases the venous oxygen content. Tissue oxygenation is further reduced when a decreased hemoglobin is present in the face of low cardiac output and increasing physiologic shunt (Moss 1974); (2) the oxygen-carrying capacity of the blood may be reduced excessively. Any decrease in hemoglobin concentration is attended by a corresponding decline in the oxygen-carrying power. Under such conditions the PaO2 remains normal, but the absolute amount of oxygen transported per unit volume of blood is diminished; (3) there may be a significant anatomic narrowing of the blood vessels; (4) oxygen tension may be reduced as the result of a right-to-left intracardiac shunt; (5) pulmonary disease results in significant hypoxemia (Ferguson and Gaensler 1968; West 1970). It is for these reasons that it is difficult to fix a level of hypoxemia at which the central nervous system cannot maintain normal function. The distinction between hypoxemia and tissue hypoxia is an important factor. There is no practical way of measuring intracellular oxygen tension. This must be inferred from the oxygen tension in the blood and from other laboratory and clinical observations (Huckabee 1965).

Compensatory mechanisms help to provide an adequate quantity of oxygen for the brain. Ventilation is controlled both directly and indirectly by central mechanisms and peripheral and central chemoreceptors.

The major central mechanisms in direct control of ventilation are the pneumotaxic, apneustic, inspiratory and expiratory centers. The pneumotaxic center located in the rostral pons regulates normal respiration and intrinsic periodicity (Hoff and Breckenridge 1949). Transection of the rostral pons or interruption of the vagi result in apneusis or cessation of respiration in deep inspriation. The pneumataxis center has no spontaneous rhythmicity, but functions as a modulator of the apneustic center (Cohen 1958). This capability is dependent upon its connection to other parts of the brainstem.

The apneustic center is located in the middle and caudal pons. This center functions to inhibit inspiration and facilitate transition to expiration. Inspiratory-expiratory phase spanning neurons located in this area facilitate and inhibit inspiration, thereby promoting expiration. In the medulla, numerous areas in the reticular formation cause inspiration or expiration upon electrical stimulation.

The peripheral chemoreceptors in the aortic and carotid bodies are designed to sense changes in blood gas tensions. They have a perfusion ten times greater than their metabolic requirements and arteriovenous shunts which can reduce blood flow to the sinusoids in the receptors. Afferent fibers from the carotid chemoreceptor join fibers from the stretch receptors in the lung and become the carotid branch of the glassopharyngeal nerve. The vagus carries afferent fibers from the aortic bodies. The afferent limb of the carotid body comes from the superior cervical ganglion.

Discharges in the afferent nerves of the peripheral chemoreceptors increase when there is: (1) a decrease in PaO2, (2) hypoperfusion and hypotension, (3) a decrease in arterial pH, (4) blood temperature elevation which stimulates the chemoreceptor cells, (5) chemical stimulation with nicotine or acetylocholine which stimulates sympathetic ganglia and also stimulates receptor cells.

The respiratory consequences seen in association with acute brain injury are due to either the direct on the respiratory center or the changes in intracranial pressure. Respiratory complications are a significant cause of late mortality (Rossanda, Selanti, and Villa 1973).

Following denervation of the peripheral chemoreceptors, 80 to 90 percent of the response to inhaled carbon dioxide remains intact, therefore, carbon dioxide is the major determinant of respiratory regulation. Variations in PaCO2 exert a profound influence on cerebral blood flow. Hypercapnia causes intense cerebral vasocilatation, and hypocapnia causes a constriction so marked that the limit of brain hypoxia is reached. Cerebral blood flow changes about 4 percent for each mm Hg change in PaCO3 (Lassen 1974).

Clinical assessment of the adequacy of oxygenation and ventilation has been shown to be unreliable (Mithoefer et al. 1968; Davis 1974), therefore, determination of arterial blood gas and pH is necessary to confirm the presence of acute respiratory insufficiency and to determine the type and degree of blood gas and acid-base abnormality which is present. Generally, blood gas abnormalities fall into three major classes: (1) metabolic acid-base disturbance, (2) ventilatory insufficiency, and (3) ventilatory failure (Pontoppidan, Gefflin, and Lowenstein 1972; Shapiro 1973; West 1974).

Metabolic acidosis is due to excess accumulation of nonvolatile acid or loss of base. Nonvolatile acid can accumulate as a result of diabetic ketoacidosis or lactic acidemia due to low cardiac output. Metabolic acidosis can also occur as a result of the inability to excrete fixed acid due to inadequate renal function. Hypoxia is rare unless the cardiovascular status is compromised or pulmonary disease coexists (Pontoppidan, Gefflin, and Lowenstein 1972; Shapiro 1973; West 1974).

In acutely compensated metabolic acidosis, hyperventilation is a major clinical feature. The basic feature of this entity is a low pH in the presence of hyperventilation. Totally compensated metabolic acidosis is characterized by a pH approximately normal and a low PaO2.

Metabolic alkalosis occurs in hypokalemia due to intravenous therapy without potassium replacement, diuretic administration, and potassium depletion from the gastrointestinal tract. Potassium is lost from the intracellular component and in order to maintain equilibrium, the H+ ion shifts from the extracellular to the intracellular space.

Steroid therapy results in sodium retention and excretion of potassium and hydrogen ion.

Respiratory alkalosis is a common clinical finding following head injury or cerebral vascular insufficiency. If there is no other injury affecting pulmonary ventilation or circulation, the PaO_2 is normal or slightly elevated (West 1974). Respiratory acidosis in the neurosurgical patient is always accompanied by hypoxia. An elevated $PaCO_2$ and a low PaO_2 are most frequently associated with aspiration and/or mechanical obstruction of the airway.

Ventilation of the traumatic head injured patient serves two functions: preventing hypoxemia and producing hypocarbia, thereby, lowering intracranial pressure. Clinical investigation of the effect of a single variable such as the ventilator is almost impossible in a situation where the disturbances vary from individual to individual, from moment to moment, and in an emergency that requires the simultaneous use of a large number of therapeutic measures.

Ventilators function to either assist or control ventilation. Assist ventilation acts to augment the patient's tidal volume. The cycling of the ventilator is initiated by the negative airway pressure produced by the patient's spontaneous respiratory effort. The ease of triggering the device depends on the sensitivity setting. Pure assist ventilators are not commonly used for treatment of respiratory failure. Control ventilation cycles automatically, as set, regardless of patient effort or lack of effort. The assist mode of ventilatory support is best used in patients with adequate respiratory drive. Such cases include pneumonia, pulmonary edema, atelectasis, emphysema, and during weaning processes. Controlled ventilation is best used in cases of apnea or insufficient respiratory drive, flail chest, paralysis, acidosis, and when the work of breathing is greatly increased. It is frequently desirable to control patients whose respiratory drive prevents control.

Ventilators are volume cycled or pressure cycled. The currently available volume cycled ventilator is preferred for the management of the majority of patients who require respiratory assistance, because of their capability of delivering a preset tidal volume, which will remain unchanged if lung compliance increases or decreases. A pressure cycled ventilator delivers a set pressure regardless of the tidal volume. Although pressure cycled ventilators adjusted to the same pressure settings and flow rates are capable of providing essentially the same ventilation as volume cycle ventilators, no compensation is made for changes which occur in lung distensibility and, therefore, tidal volume and alveolar ventilation become inadequate if lung compliance decreases. Comparison of ventilators is difficult because it requires consideration of the interaction of two machines: the mechanical pump and the human cardiorespiratory system (Jones, MacNamara, and Gaensler 1960; West 1974).

Summary

The two major areas of concern to this study have been examined in detail. In the first section, consciousness was defined as an expression and awareness of an aroused mind with a total complement of integrative functions which adapt and relate man to his environment. Consciousness has been recognized as a parameter to measure intracranial pressure as the result of supratentorial and infratentorial lesions. Further assessment of patients with supratentorial and infratentorial lesions has been discussed by identifying the clinical parameters of the Glasgow Coma Scale. The second section of the review of literature has discussed oxygenation as a physiologic change of events. Clinical assessment of the mechanisms for oxygenation have been examined by identifying parameters and processes for ventilation.

CHAPTER III

PROCEDURE FOR COLLECTION AND TREATMENT OF DATA

Introduction

This research was conducted to determine the correlation between the degree of oxygenation and the level of consciousness in patients with traumatic head injury, who were mechanically ventilated. Chapter III discussed the setting, population, and research tool used to collect the data and identifies the methodology utilized for collecting and analyzing the data.

Setting

The setting for this research was the medical records department of a university medical center in a large metropolitan city in the southwestern United States. This over one thousand bed capacity institution is affiliated with a school of medicine and college of nursing.

Population and Sample

The population for this research were patients sustaining head injury, as the result of trauma, between June 1975 and September 1978. This period of time demonstrated an occurrence of diagnosed head injury in 367 patients. A sample of the first 100 from the 367 medical records reviewed was collected by the convenience sample method.

Tool

The development of the data collection tool used for this research is based on the following framework: the Glasgow Coma Scale, the clinical application of respiratory physiology by West(1974), and an exhaustive review of the literature. The Glasgow Coma Scale evolved for assessing the depth and duration of impaired consciousness and coma. Three aspects of behavior are independently measured: (1) motor responsiveness, (2) verbal performance, and (3) eye opening. In testing the validity and reliability of the scale, it was shown that different observers were able to elicit responses with a high degree of consistency. The likelihood of ambiguous reporting was small. This was demonstrated with both doctors and nurses assessed the same group of patients. Disagreements were rare. This was in pronounced contrast to the group of observers who were asked instead to judge whether patients were either conscious or unconscious. One in five observers disagreed with the majority opinion. This 20 percent disagreement-rate compared with rates of 20 to 35 percent which have been reported in other clinical situations (Teasdale, Knill-Jones, and Jennett 1974). The Glasgow Coma Scale provides an effective method of describing the various states of impaired consciousness encountered in clinical practice and demonstrates an applicable scheme of assessment.

A pilot study was conducted between August and September 1978 at a one thousand bed capacity institution in the northeastern United States. The pilot study was undertaken to detect ambiguity in the researcher-designed tool; difficulties in scoring the information; and a time reference. Data from ten medical records of patients with diagnosed head trauma were analyzed. The initial testing showed low positive correlations. The researcher cautions that the extent of validity and reliability of the tool will not be fully known until it is appropriately used in a number of studies. An example of the revised data collection tool is shown in Appendix A.

Collection of Data

The approval of the Human Research and Review Committee of Texas Woman's University was secured prior to the collection of data (Appendix B). Authorized permission for conducting this research was granted by the agency's administrative body. Conditions of agreement are outlined in Appendix C.

The medical records of prior admitted head injured patients were obtained by the agency's medical records personnel. The one hundred medical records reviewed were identified by computerized categorization under the listing of Head Injury. Each of the records was reviewed by the medical records personnel to see if the criteria for the research was obtainable before being introduced into the study. After the one hundred medical records were identified, the records were categorized into two groups designated supratentorial lesions (Group ST) and infratentorial lesions (Group IT). There were fifty patients in each group.

The data, in accordance with the Consciousness-Ventilation Flow Sheet, were collected by the researcher from the nurses' notes, graphic sheet, laborabory reports, and respiratory flow sheet. The time sequence was the first and last day of ventilation.

Treatment of Data

The data obtained from the Consciousness-Ventilation Flow Sheet were analyzed by using the Kendall's Tau B correlation coefficient and the Chi square test. Kendall's Tau B was used to correlate the degree of oxygenation with the level of consciousness; the degree of oxygenation with the clinical parameters; and the level of consciousness with the clinical parameters. For each of the clinical parameters and degree of oxygenation and level of consciousness variables an ordinal rating was given to represent the change in the status of the patient for that variable from the first day of ventilation to the last. The rating assigned the patient to one of three categories on the basis of the serial assignments of their state. These categories were: (1) patients whose condition improved, (2) patients who condition stabilized, and (3) patients whose condition deteriorated. Analyses were run on the rating variables to determine if changes in the status of the patient for one variable was related to that of another variable.

A rating variable was not given for the ventilatory measures but instead only the first day of ventilation value was used for the type of ventilator, FiO2, and rate. The Chi square test was used to compare the types of ventilators on the degree of oxygenation and the level of consciousness variables. The ventilatory measures of FiO2 and rate were correlated with the level of and degree of oxygenation using Kendall's Tau B. In the comparison of the two groups of lesion sites, supratentorial and infratentorial, the analysis of both groups was subjectively compared from the data obtained.

Summary

Chapter III contained the procedures utilized in the collection and treatment of data for this research study. The results of the analysis appear in Chapter IV of the study and are augmented by tables and descriptive explanations.

CHAPTER IV

ANALYSIS OF DATA

Introduction

The intent of this research was to examine whether compensatory controlled oxygenation effects the level of consciousness in patients with traumatic head injury. The purposes of the study were:

1. To correlate the degree of oxygenation with the clinical parameters of blood pressure, pulse pressure, pulse, and temperature in patients with a supratentorial lesion

2. To correlate the degree of oxygenation with the clinical parameters of blood pressure, pulse pressure, pulse, and temperature in patients with an infratentorial lesion

3. To compare the mechanical mechanisms of ventilation on the degree of oxygenation in patients with a supratentorial lesion

4. To compare the mechanical mechanisms of ventilation on the degree of oxygenation in patients with an infratentorial lesion

5. To correlate the level of consciousness with the clinical parameters of blood pressure, pulse pressure,

pulse, and temperature in patients with a supratentorial lesion

6. To correlate the level of consciousness with the clinical parameters of blood pressure, pulse pressure, pulse, and temperature in patients with an infratentorial lesion

7. To compare the mechanical mechanisms of ventilation on the level of consciousness in patients with a supratentorial lesion

8. To compare the mechanical mechanisms of ventilation on the level of consciousness in patients with an infratentorial lesion

9. To compare the relationship of degree of oxygenation and level of consciousness between patients with a supratentorial lesion and patients with an infratentorial lesion

Description of Sample

The sample of one hundred medical records was drawn from one location. The location was the medical records department of a university medical center in a large metropolitan city in the southwestern United States.

Each medical record supplied data for the *Consciousness-Ventilation Flow Sheet* which was collected from the nurses' notes, graphic sheet, laboratory reports, and respiratory flow sheet. The one hundred medical records analyzed included patients between the ages of 18 and 35 years. Males comprised a total of 82 percent (82 subjects) and females 18 percent (18 subjects). All patients with non-iatrogenic cardiopulmonary disorders had a primary medical diagnosis of a supratentorial or infratentorial lesion confirmed by skull x-ray and/or computerized axial tomography. In the intensive care unit, these patients were either intubated or had tracheostomies and were mechanically ventilated for a period of at least four hours before being introduced into the study. Of the total sample of one hundred medical records, fifty were in the category of supratentorial (Group ST) while the other fifty were in the category of infratentorial lesion (Group IT).

Analysis of the Data

The relationship between compensatory controlled oxygenation and the level of consciousness was tested by the statistical analysis of Kendall's Tau B correlation coefficient and the Chi square test. Each variable was numerically categorized into regions based upon normal values. A rating of change from the pre and post level status of each patient from the initial day of treatment to last day of treatment on the respirator. A significance level of .05 was utilized throughout. The parameters of degree of oxygenation and level of consciousness will be discussed separately with the purposes and hypotheses in the following sections.

Degree of Oxygenation

Hypothesis #1: There was no relationship between the degree of oxygenation and the clinical parameters. In analyzing the correlation of the degree of oxygenation with the clinical parameters of blood pressure, pulse pressure, pulse, and temperature in patients with either a supratentorial or infratentorial lesion, it was found that within Group ST there was a significant correlation between changes in the degree of oxygenation and changes in certain clinical parameters. There was a correlation between the hemoglobin and hematocrit with the systolic blood pressure. The level of significance was 0.01. There was a correlation between the pH and diastolic blood pressure. The level of significance was 0.04. There was a correlation between the $PaCO_2$ and diastolic blood pressure. The level of significance was 0.04. There was a correlation between the HCO_3 and diastolic blood pressure.

The level of significance was 0.03. There was a correlation between the PaO2 and pulse. The level of significance was 0.03. The data are presented in Table 1.

TABLE 1

CORRELATION OF CHANGES IN THE DEGREE OF OXYGENATION VARIABLES WITH CHANGES IN THE CLINICAL PARAMETERS FOR GROUP ST

Clinical Parameter	pH	PaCO2	PaO2	HcO3	O2 Sat.	Hgb.	Hct.
Systolic Blood Pressure	0.01	0.10	-0.16	0.24	0.00	0.38*	0.38*
Diastolic Blood Pressure	0.28*	0.27*	-0.23	0.28*	0.00	0.14	0.14
Pulse Pressure	0.24	0.08	0.03	-0.09	0.00	0.07	0.07
Pulse	-0.02	-0.11	-0.16	-0.04	0.00	0.08	0.08
Temperature	-0.02	-0.11	-0.16	-0.04	0.00	0.08	0.08

N = 50
Kendall's Tau B correlation coefficient
* = $p < .05$

However, within Group IT, there was no significant correlation. Hypothesis #1 was accepted in the null for only those patients with infratentorial lesions.

Hypothesis #2: There was no no relationship between the degree of oxygenation and ventilatory measures.

The comparison of the mechanical mechanisms of ventilation on the degree of oxygenation was studied by the Chi square test. In the analysis, each variable representing the change in the degree of oxygenation from the first to last day of ventilation was compared between control and assist ventilation. The variables were the pH, PaCO2, PaO2, HCO3, O2 saturation, hemoglobin, and hematocrit. Each of these variables is discussed separately.

In comparing control and assist ventilation to pH in patients with a supratentorial lesion, a Chi square of 6.01 with 2 degrees of freedom and a significance of 0.05 was found. The data for this comparison are presented in Table 2.

TABLE 2

CONTROL VERSUS ASSIST VENTILATION ON pH STATUS FOR GROUP ST

Ph	Control Ventilation	Assist Ventilation
Condition Deteriorated	f = 5 29.4%	f = 2 6.1%
Condition Stable	f = 5 29.4%	f = 8 24.2%
Condition Improved	f = 7 41.2%	f = 23 69.7%

N = 50
Chi square = 6.01 with 2 degrees of freedom
Significant 0.05

In comparing control and assist ventilation to pH in patients with an infratentorial lesion, a Chi square of 2.47 with 2 degrees of freedom and a significance of 0.29 was found. The evidence from these tests indicates that patients with supratentorial lesions under assist ventilation demonstrated more improvement in pH status compared to those under control ventilation. There was no evidence to indicate that either type of ventilation improved the patient's pH status in infratentorial lesions.

In comparing control and assist ventilation to PaCO2 in patients with a supratentorial lesion, a Chi square of 3.25 with 2 degrees of freedom and a significance of 0.20 was found. In comparing control and assist ventilation to PaCO2 in patients with an infratentorial lesion, a Chi square of 1.17 with 2 degrees of freedom and a significance of 0.56 was found. There was no evidence to indicate that either type of ventilation resulted in a comparison with the patient's PaCO2 status in both supratentorial and infratentorial lesions.

In comparing control and assist ventilation to PaO2 in patients with a supratentorial lesion, a Chi square of 2.71 with 2 degrees of freedom and a significance of 0.26 was found. In comparing control and assist ventilation with regard to PaO2 in patients with an infratentorial lesion, a Chi square of 3.74 with 2 degrees of freedom and a significance of 0.15 was found. There was no evidence to indicate that either type of ventialtion resulted in a comparison with the patient's PaO2 status in both supratentorial and infratentorial lesions.

In comparing control and assist ventilation to HCO3 in patients with a supratentorial lesion, a Chi square of 10.3 with 2 degrees of freedom and a significance of 0.01 was found. The data for this comparison are presented in Table 3.

TABLE 3

CONTROL VERSUS ASSIST VENTILATION ON HCO3 STATUS FOR GROUP ST

HCO3	Control Ventilation	Assist Ventilation
Condition Deteriorated	f = 7 41.2%	f = 2 6.1%
Condition Stable	f = 4 23.5%	f = 7 21.2%
Condition Improved	f = 6 35.3%	f = 24 72.7%

N = 50
Chi square = 10.3 with 2 degrees of freedom
Significance 0.01

In examining control and assist ventilation with regard to HCO3 in patients with an infratentorial lesion, a Chi square of 3.30 with 2 degrees of freedom and a significance of 0.19 was found. The evidence from these tests indicated that patients with supratentorial lesions under assist ventilation demonstrated more improvement in HCO3 status as compared to patients under control ventilation. There was no evidence to indicate that either type of ventilation improved the patient's HCO3 status in infratentorial lesions.

In comparing control and assist ventilation to 02 saturation in patients with a supratentorial lesion or infratentorial lesion showed no significance to be reported. In comparing control or assist ventilation to the hemoglobin and hematocrit in patients with a supratentorial lesion, a Chi square of 7.95 with 2 degrees of freedom and a significance of 0.01 was found. The data for this comparison are presented in Table 4.

TABLE 4

CONTROL VERSUS ASSIST VENTILATION ON HEMOGLOBIN AND HEMATOCRIT STATUS FOR GROUP ST

Hemoglobin Hematocrit	Control Ventilation	Assist Ventilation
Condition Stable	f = 9 52.9%	f = 5 15.1%
Condition Improved	f = 8 47.1%	f = 28 84.9%

N = 50
Chi square = 7.95 with 2 degrees of freedom
Significance 0.01

In comparing control and assist ventilation with regard to hemoglobin and the hematocrit in patients with an infratentorial lesion, a Chi square of 1.55 with 2 degrees of freedom and a significance of 0.46 was found. The evidence from these tests indicated that patients with supratentorial lesions under assist ventilation demonstrated more improvement in their hemoglobin and hematocrit status as compared to patients under control ventilation. There was no evidence to indicate that either type of ventilation improved the patients' hemoglobin and hematocrit status in infratentorial lesions.

In examining the further mechanical mechanisms of FiO_2 and rate with the degree of oxygenation in patients with supratentorial lesions, it was discovered that there was a significant correlation between changes in the degree of oxygenation and in either the FiO_2 or rate. There was a correlation between the FiO_2 and the pH. The level of significance was 0.02. There was a correlation between the rate and the $PaCO_2$. The level of significance was 0.02. There was a correlation between the rate and the HCO_3. The level of significance was 0.01.

In examining the further mechanical mechanisms of FiO_2 and rate with the degree of oxygenation in patients with an infratentorial lesion, it was discovered that there was a significant correlation between changes in the degree of oxygenation and either the Fi02 or rate. The correlation was between the rate and the PaCO2. The level of significance was 0.03. The data for this correlation are presented in Table 5.

TABLE 5

CORRELATION OF CHANGES IN DEGREE OF OXYGENATION VARIABLES WITH THE Fi02 AND RATE

Clinical Parameters	Fi02 Group ST	Fi02 Group IT	Rate Group ST	Rate Group IT
Ph	-0.31*	0.16	-0.40*	-0.21
PaC02	-0.15	-0.04	-0.34*	0.31*
Pa02	-0.61	-0.19	0.25	0.22
HCO3	-0.23	-0.21	-0.39*	0.03
02 Sat	0.00	0.00	0.00	0.06
Hgb.	-0.26	0.52	-0.23	0.04
Hct.	-0.26	0.52	-0.23	0.04

N = 100
Kendall's Tau B correlation coefficient
* = $p < .05$

The evidence from these tests indicated a significant negative correlation between the Fi02 and pH, and the rate with the pH, PaCO2, and HCO3 in patients with supratentorial lesions, however, patients with infratentorial lesions showed a significant positive correlation between rate and $PaCO_2$. Hypothesis #2 was not accepted in the null for either supratentorial or infratentorial lesions.

Level of Consciousness

Hypothesis #3: There was no relationship between the level of consciousness and the clinical parameters. In analyzing the correlation of the level of consciousness with the clinical parameters of blood pressure, pulse pressure, pulse, and temperature in patients with either a supratentorial or infratentorial lesion it was found that within Group ST there was a correlation between changes in the level of consciousness and changes in certain clinical parameters. There was a correlation between the level of consciousness and the systolic blood pressure. The level of significance was 0.0001. There was a correlation between the level of consciousness and the diastolic blood pressure. The level of significance was 0.0001.

Within Group IT, there was a correlation between specific changes in the level of consciousness and changes in certain clinical parameters. There was a correlation between the level of consciousness and systolic blood pressure. The level of significance was 0.03. The data are presented in Table 6.

TABLE 6

CORRELATION OF CHANGES IN THE LEVEL OF CONSCIOUSNESS WITH CHANGE IN THE CLINICAL PARAMETERS

Clinical Parameters	Level of Consciousness Group ST	Group IT
Systolic Blood Pressure	0.54*	0.29*
Diastolic Blood Pressure	0.54*	0.21*
Pulse Pressure	0.15	0.12
Pulse	0.29	0.22
Temperature	0.20	0.10

N = 100
Kendall's Tau B correlation coefficient
* = $p < .05$

The evidence from these tests indicated that the level of consciousness positively correlated with the systolic and diastolic blood pressure in patients with a supratentorial lesion, however, in patients with an infratentorial lesion the level of consciousness positively correlated with the systolic blood pressure. Hypothesis #3 was not accepted in the null for those patients with a supratentorial or infratentorial lesion.

Hypothesis #4: There was no relationship between the level of consciousness and ventilatory measures. The comparison of the mechanical mechanisms of ventilation on the level of consciousness was studied by the Chi square test. In comparing the level of consciousness with regard to the mechanical mechanisms of ventilation in patients with a supratentorial lesion, a Chi square of 24.3 with 1 degree of freedom and a significance of 0.0001 was found. The data for this comparison are presented in Table 7.

TABLE 7

CONTROL VERSUS ASSIST VENTILATION ON LEVEL OF CONSCIOUSNESS STATUS FOR GROUP ST

Level of Consciousness	Control Ventilation	Assist Ventilation
Condition Deteriorated	f = 10 58.8%	f = 0 0.0%
Condition Improved	f = 7 41.2%	f = 33 100%

N = 50
Chi square = 24.3 with 1 degree of freedom
Significance 0.0001

In examining the level of consciousness with regard to the mechanical mechanisms of ventilation in patients with regard to the mechanical mechanisms of ventilation in patients with an infratentorial lesion, a Chi square of 5.68 with 1 degree of freedom and a significance of 0.02 was found. The data for this comparison are presented in Table 8.

TABLE 8

CONTROL VERSUS ASSIST VENTILATION ON LEVEL OF CONSCIOUSNESS STATUS FOR GROUP IT

Level of Consciousness	Control Ventilation	Assist Ventilation
Condition Deteriorated	f = 32 96.7%	f = 12 75.0%
Condition Improved	f = 1 3.03%	f = 4 25.0%

N = 50
Chi square = 5.68 with 1 degree of freedom
Significance 0.02

The evidence from these tests indicated that patients with supratentorial lesions under assist ventilation demonstrated more improvement in their level of consciousness compared to those under control ventilation. A significant number of patients with infratentorial lesions, however, under control ventilation demonstrated a deterioration of level of consciousness.

In comparing the further mechanical mechanisms of Fi02 and rate with the level of consciousness, it was discovered that there was no correlation between changes in the level of consciousness and changes in the mechanical mechanisms of FiO_2 and rate in either supratentorial or infratentorial lesions.

Hypothesis #4 was not accepted in the null for those patients with either a supratentorial or an infratentorial lesion.

Hypothesis #5: There was no difference between the degree of oxygenation and the level of consciousness between patients with a supratentorial lesion and patients with an infratentorial lesion. In comparing the relationship of the degree of oxygenation with the level of consciousness in patients with either a supratentorial or infratentorial lesion, it was found that within Group ST there was a correlation between changes in the degree of oxygenation and changes in the level of consciousness. There was a correlation between the change in the level of consciousness and the pH. The level of significance was 0.03. There was a correlation between change in the level of consciousness and the HCO_3. The level of significance was 0.01.

Within Group IT, there was a correlation between specific changes in the degree of oxygenation and changes in the level of consciousness. There was a correlation between the change in the level of consciousness and the PaO2. The level of significance was 0.01. There was a correlation between the change in the level of consciousness and the HCO3. The level of significance was 0.05. The data are presented in Table 9.

TABLE 9

COMPARISON OF THE RELATIONSHIP OF DEGREE OF OXYGENATION AND LEVEL OF CONSCIOUSNESS

Degree of Oxygenation	Group ST	Group IT
pH	0.31*	0.37*
PaCO2	0.10	0.39*
PaO2	0.09	0.10
HCO3	0.35*	0.27
O2 Sat.	0.00	0.05
Hgb	0.25	0.15
Hct.	0.25	0.15

N = 100
Kendall's Tau B correlation coefficient
* = $p < .05$

The evidence from these tests revealed a significant and positive correlation between the level of consciousness and the degree of oxygenation variable pH and HCO3 in supratentorial lesions. In patients with infratentorial lesions, there was a significant and positive correlation between the level of consciousness and the degree of oxygenation variable pH, PaC02, and HC03. Hypothesis #5 was not accepted in the null for those patients with either supratentorial or infratentorial lesion.

Summary

The analysis of the data in relation to the purposes of the study has been presented. The parameters of degree of oxygenation and level of consciousness will be discussed separately.

Degree of Oxygenation

In analyzing the correlation of the degree of oxygenation with the clinical parameters, it was found that the variables of hemoglobin and hematocrit for measuring the degree of oxygenation positively correlated with the clinical parameter of systolic blood pressure. Other variables for measuring the degree of oxygenation, namely pH, PaC02, and HC03 positively correlated with the clinical parameter of diastolic pressure, however, the Pa02 negatively correlated with the pulse. These correlations were significant. The 02 saturation found no association to the clinical parameters. The PaC02 and Pa02 to the systolic blood pressure; the Pa02 to the diastolic blood pressure; the HC03 to pulse pressure, and pH, PaC02, Pa02, and HC03 to the temperature were found to be negatively correlated, although not significantly. In patients with an infratentorial lesion, no significant correlation was shown between variables for the degree of oxygenation and the clinical parameters.

The comparison of the mechanical mechanisms of ventilation on the degree of oxygenation in patients with supratentorial lesions revealed evidence to indicate that patients under assist ventilation demonstrated more improvement in their pH, HC03, hemoglobin, and hematocrit status, however, there was no evidence of either type of ventilation affecting the degree of oxygenation status in patients with infratentorial lesions. The mechanical mechanisms of Fi02 and rate negatively correlated to all the variables measuring the degree of oxygenation, however, only the Fi02 with the pH and the rate with the pH, PaC02, and HC03 were significant. The 02 saturation found no association to the mechanical mechanisms of Fi02 and rate.

In patients with infratentorial lesions, the rate positively correlated with the PaC02 and significantly so. Examination of the Fi02 in relationship to the PaC02, Pa02, and HC03 were negatively correlated, however, the

FiO_2 positively correlated with the pH, hemoglobin, and hematocrit although not significantly so in each case. The rate negatively correlated to the pH while the rate positively correlated to the PaO_2, HCO_3, O_2 saturation, hemoglobin, and hematocrit although not significantly so.

Level of Consciousness

In analyzing the correlation of the level of consciousness with the clinical parameters, it was found that in patients with supratentorial lesions the level of consciousness positively correlated with the systolic and diastolic blood pressure. The level of consciousness positively correlated with the systolic blood pressure in patients with infratentorial lesions. The level of consciousness positively correlated with other clinical parameters of pulse pressure, pulse, and temperature although not significantly so.

The comparison of the mechanical mechanisms of ventilation on the level of consciousness revealed evidence to indicate that patients with supratentorial lesions under assist ventilation demonstrated more improvement in the level of consciousness compared to those under control ventilation, however, a significant number of patients with infratentorial lesions under control ventilation demonstrated a deterioration of level of consciousness. In comparing the mechanical mechanisms of FiO2 and rate, there was no correlation between changes in level of consciousness and the mechanical mechanisms in either supratentorial of infratentorial lesions.

Finally, in analyzing the relationship of the degree of oxygenation and level of consciousness in patients with a supratentorial or infratentorial lesion, it was found that all the variables measuring the degree of oxygenation positively correlated to the level of consciousness, however, only the pH and HCO3 in Group ST and the pH, PaCO2 and HCO3 in Group IT were of significance.

CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Summary

This study was conducted to determine whether compensatory controlled oxygenation affects the level of consciousness in patients with traumatic head injury. The purposes of the study were:

1. To correlate the degree of oxygenation with the clinical parameters of blood pressure, pulse pressure, pulse, and temperature in patients with a supretentorial lesion

2. To correlate the degree of oxygenation with the clinical parameters of blood pressure, pulse pressure, pulse, and temperature in patients with an infratentorial lesion

3. To compare the mechanical mechanisms of ventilation on the degree of oxygenation in patients with a supratentorial lesion

4. To compare the mechanical mechanisms of ventilation on the degree of oxygenation in patients with an infratentorial lesion

5. To correlate the level of consciousness with the clinical parameters of blood pressure, pulse pressure, pulse, and temperature in patients with a supratentorial lesion

6. To correlate the level of consciousness with the clinical parameters of blood pressure, pulse pressure, pulse, and temperature in patients with an infratentorial lesion

7. To compare the mechanical mechanisms of ventilation on the level of consciousness in patients with a supratentorial lesion

8. To compare the mechanical mechanisms of ventilation on the level of consciousness in patients with an infratentorial lesion

9. To compare the relationship of degree of oxygenation and level of consciousness between patients with a supratentorial lesion and patients with an infratentorial lesion

The Consciousness-Ventilation Flow Sheet subscores were subjected to Kendall's Tau B correlation coefficient or the Chi square test depending on the nature of the data for determination of the correlation of compensatory controlled oxygenation with the levels of consciousness in patients with traumatic head injury.

For patients with supratentorial lesions, the clinical parameters of blood pressure and pulse, and the mechanical mechanisms of Fi02 and respiratory rate were associated with compensatory controlled oxygenation. The clinical parameter of blood pressure was associated with the level of consciousness status.

For patients with infratentorial lesions, only the mechanical mechanism of respiratory rate predicted the effect of compensatory controlled oxygenation. The clinical parameter of systolic blood pressure was associated with the level of consciousness status.

For patients with either a supratentorial or infratentorial lesion, lab data evaluating the degree of effectiveness of compensatory controlled oxygenation was found to be predictive in evaluating the level of consciousness status. Finally, all patients on assisted ventilation had improved levels of consciousness in comparison to those patients on control ventilation. In summary, certain aspects of compensatory controlled oxygenation correlated significantly with the level of consciousness in patients with traumatic head injury.

Discussion and Conclusions

In response to the primary intent of this study, it was found that compensatory controlled oxygenation remains an uncertain determinant of the level of consciousness in patients with a supratentorial or infratentorial lesion. Certain aspects identifying the compensatory controlled oxygenation, in relationship to the level of consciousness, were determinants. These aspects will be later discussed with reference to the clinical parameters, the mechanical mechanisms of ventilation, the laboratory data, and the level of consciousness score.

A possibility for compensatory controlled oxygenation not being a determinant of the level of consciousness is that there is a distinction between hypoxemia and tissue hypoxia. There is no practical way of measuring intracellular oxygen tension. Compensatory controlled oxygenation helps to provide an adequate quantity of oxygen for the brain, however, this must be inferred from the oxygen tension in the blood and from other laboratory and clinical observations (Huckabee 1965).

Another possibility is in the type of traumatic head injury. From this study, and with this sample, patients with supratentorial lesions had a better survival rate (36 out of 50) than patients with infratentorial lesions (4 out of 50), however, the overall rate of these patients was poor. This poor survival rate can infer that the intervention of compensatory controlled oxygenation may not be effective due to the severity of the lesion site; and other interventions by health professionals may not be effective for decreasing the mortality rate.

Analysis of the data in patients with supratentorial lesions showed a significant relationship between the change in the hemoglobin and hematocrit status from the first to last day of ventilation and the systolic blood pressure change from the first to last day of ventilation. Improvement in the hemoglobin and hematocrit status prevents a decrease in the cardiac output and consequent improvement in the oxygen transport to the tissue (Shapiro 1975).

Other significant relationships were between the pH, PaC02, and HC03, respectively from the first to last day of ventilation and the diastolic blood pressure change from the first to last day of ventilation. Patients under assist ventilation from the first day of ventilation demonstrated more improvement in their pH, HC03, hemoglobin and hematocrit status from the first to last day of ventilation, however the Pa02 showed an inverse relationship to the pulse. One of the findings that also emerged from this part of the study was that of the significantly inverse relationship of the initial Fi02 and rate with the arterial blood gas results and the hemoglobin and hematocrit from the first to last day of ventilation.

In the hypoxic state, increased cardiac output caused by decreased total peripheral resistance is due to local vasodilation resulting from lack of oxygen. The PaC02 and pH measurements give the health professional a physiologic reflection of the ventilatory and acid base status. The major significance of the PaC02 measurement is that it is an immediate measurement of the adequacy or inadequacy of alveolar ventilation.

The ventilator supports the cardiovascular system significantly and when the work of breathing is only assisted by the ventilator, the blood pressure and cardiac rate increases. Also, patients with supratentorial lesions are placed on assist ventilators more readily than infratentorial on admission as the result of an intact brain stem and spontaneous respirations. Their level of consciousness on admission is usually higher than that of the patients with an infratentorial lesion. For patients with infratentorial lesions, the initial rate from the first day of ventilation showed a significant relationship with the PaC02.

Analysis of the data concerning the level of consciousness and clinical parameters showed the systolic and diastolic blood pressure as a significant relationship in reference to the change from the first to last day of ventilation. In patients with an infratentorial lesion, the relationship was with only the systolic blood pressure.

Patients with supratentorial lesions under assisted ventilation demonstrated improvement in the level of consciousness from the first to last day of ventilation, however, patients with infratentorial lesions under control ventilation had neurological deterioration in their level of consciousness. This is similar to the relationship of the type of ventilator and degree of oxygenation. The severity of an infratentorial lesion and its devastating effects on the brain stem is a possibility for this finding.

Finally, in the analysis of the degree and level of consciousness in patients with supratentorial lesions, only the parameter of pH and HC02 for determining the degree of oxygenation was significant. In patients with infratentorial lesions, only the parameters of pH, PaC02, and HC03 for determining the degree of oxygenation was significant.

For this study and sample, the classic Cushing reflex of a rising systolic blood pressure, a widening pulse pressure, and a slowing pulse was not significantly seen in either supratentorial or infratentorial lesions. Possibilities may be in relationship to the high doses of steroids given as the medical regimen to decrease intracranial blood pressure. Also, it may be possible to have seen the Cushing reflex if the data were analyzed on a day to day basis versus the first and last day of ventilation since intracranial pressure peaks in the first forty-eight to seventy-two hours.

Implications

The parameters of degree of oxygenation and level of consciousness will be discussed separately and in reference to either supratentorial or infratentorial lesions.

Degree of Oxygenation

The results of the study indicate for health professions that:

For Supratentorial Lesions

1. Improvement in the hemoglobin and hematocrit from the first to last day of ventilation is associated

with an improvement in the systolic blood pressure from the first to last day of ventilation; the converse is true

2. Improvement in the pH, PaC02, and HC03 from the first to last day of ventilation is associated with an improvement in the diastolic blood pressure from the first to last day of ventilation; the converse is true

3. Improvement in the Pa02 from the first to last day of ventilation is associated with a decrease in the pulse from the first to last day of ventilation; the converse is true

4. Patients under assist ventilation from the first day of ventilation have an associated improvement in their pH, HC03, hemoglobin, and hematocrit from the first to last day of ventilation

5. If there is an increase in the Fi02 on the first day of ventilation, there is an associated decrease in the pH from the first to last day of ventilation; the converse is true

6. If there is an increase in the rate on the first day of ventilation, there is an associated decrease in the pH, PaC02, and HC03 from the first to last day of ventilation; the converse is true

For Infratentorial Lesions

1. An increased respiratory rate on the first day of ventilation is associated with an increase in the $PaCO_2$ from the first to last day of ventilation

Level of Consciousness

The results of the study indicate for health professional that:

For Supratentorial Lesions

1. Improvement in the level of consciousness from the first to last day of ventilation is associated with an increase in the systolic and diastolic blood pressure from the first to last day of ventilation; the converse is true

2. Patients under assist ventilation on the first day of ventilation have an associated improvement in their level of consciousness from the first to last day of ventilation

3. Improvement in the pH and HCO_3 from the first to last day of ventilation is associated with an increase in the level of consciousness from the first to last day of ventilation; the converse is true

For Infratentorial Lesions

1. Improvement in the level of consciousness from the first to last day of ventilation is associated with an increase in the diastolic blood pressure from the first to last day of ventilation; the converse is true

2. Patients under control ventilation on the first day of ventilation have an associated deterioration in their level of consciousness from the first to last day of ventilation

3. Improvement in the pH and PaC02 from the first to last day of ventilation is associated with an improvement in the level of consciousness from the first to last day of ventilation; the converse is true

Recommendations

Recommendations for replication of this study with changes are as follows:

1. Replication of this study with a more homogeneous sample

2. Replication of this study with a measurement of the change in the level of consciousness correlated with the degree of oxygenation from day to day

3. Replication of this study with direct assessment of the patient's neurological and pulmonary status by the researcher

Recommendations for further studies in related areas as follows:

1. Examination of correlations between the level of consciousness and steroid therapy

2. Examination of correlations between the level of consciousness and the mechanical mechanisms of PEEP, IMV, tidal volume, or minute ventilation

3. Examination of correlations between the level of consciousness and cardiac output or A-a gradient

4. Examination of correlations between the level of consciousness and serum electrolytes

APPENDIX A

Consciousness-Ventilation Flow Sheet

CONSCIOUSNESS-VENTILATION FLOW SHEET

Patient No.:

Age: Sex:

Site of intracranial lesion:

Cause:

	First Day of Venti- lation	Last Day of Venti- lation
Ventilation day No.		
Time		
Vital Signs:		
Blood Pressure		
Pulse Pressure		
Pulse		
Temperature		
Pupils:		
Equal		
Unequal		
Reactive		
Non-reactive		
Level of Consciousness:		
Grade Five (5 points each)		
1. Alert		
2. Orientation		
Person		
Place		
Time		
3. Answers appropriately		

	First Day of Venti-lation	Last Day of Venti-lastion
4. Arousable to verbal stimuli		
5. Purposeful motor response to verbal command		
Grade Four (4 points each)		
1. Lethargic, restless, uncooperative		
2. Orientation		
Person		
Place		
3. Answers appropriately		
4. Arousable to verbal or tactile stimuli		
5. Purposeful motor response to verbal command or tactile stimuli		
Grade Three (3 points each)		
1. Stuporous		
2. Orientation		
Person		
3. Answers inappropriately		
4. Arousable to verbal, tactile, or pain stimuli		
5. Purposeful or semi-purposeful motor response to verbal, tactile or pain stimuli		
Grade Two (2 points each)		
1. Deep Stupor		
2. No orientation		
3. Incomprehensible sounds		
4. Arousable to tactile or pain stimuli		
5. Purposeful of semi-purposeful motor response to verbal, tactile or pain stimuli		

	First Day of Ventilation	Last Day of Ventilation
Grade One (1 point each)		
1. Semi-comatose		
2. No orientation		
3. No verbal response		
4. Non-arousable to verbal, tactile, or pain stimuli		
5. Decerebration or decortication (motor response)		
Grade Zero (no points)		
1. Comatose		
2. No orientation		
3. No verbal response		
4. Non-arousable to verbal, tactile, or pain stimuli		
5. No motor response Flaccid		
Total points (LOC):		
Mechanical Mechanisms of Ventilation:		
Ventilator		
Pressure cycled		
Volume cycled		
Control ventilation		
Assist ventilation		
Fi02		
Rate		
Lab Data:		
Arterial Blood Gas		
pH		
< 7.35		
7.35-7.45		
> 7.45		

	First Day of Venti- lation	Last Day of Venti- lation
PaC02		
< 35 mm. Hg		
35-45 mm. Hg		
> 45 mm. Hg		
Pa02		
< 75 mm. Hg		
75-100 mm. Hg		
> 100 mm. Hg		
HC03		
< 22 mEq l.		
22-26 mEq l.		
> 26 mEq l.		
02 saturation		
90-100%		
85-89%		
86-84%		
< 35%		
Hemoglobin		
Male		
< 13 gm 100 ml.		
13-16 gm 100 ml.		
> 16 gm 100 ml.		
Female		
< 12 gm 100 ml.		
12-14 gm 100 ml.		
> 14 gm 100 ml.		
Hematocrit		
Male		
< 42		
42-50		
> 50		
Female		
< 40		
40-48		
> 48		

APPENDIX B

Human Research Review Committee Permission

TEXAS WOMAN'S UNIVERSITY

Human Research Committee

Name of Investigator: Diane Elizabeth Schull Center: Dallas

Address: 6225 Bordeaux, Apt. 201

Dallas, Texas 75209

Dear Ms. Schull:

Your study entitled Compensatory Controlled Oxygenation and the Level of Consciousness in Patients with Traumatic Head Injury has been reviewed by a committee of the Human Research Review Committee and it appears to meet our requirements in regard to protection of the individual's rights.

Please be reminded that both the University and the Department of Health, Education and Welfare regulations require that written consents must be obtained from all human subjects in your studies. These forms must be kept on file by you.

Furthermore, should your project change, another review by the Committee is required, according to DHEW regulations.

Sincerely,

Geraldine M. Goldman

Chairman, Human Research
Review Committee
at Dallas.

APPENDIX C

Agency Permission

TEXAS WOMAN'S UNIVERSITY
COLLEGE OF NURSING
DENTON, TEXAS

DALLAS CENTER
1810 Inwood Road
Dallas, Texas 75235

HOUSTON CENTER
1130 M.D. Anderson Blvd.
Houston, Texas 77025

AGENCY PERMISSION FOR CONDUCTING STUDY*

THE [illegible]

GRANTS TO Diane Elizabeth Schull

a student enrolled in a program of nursing leading to a Master's Degree at Texas Woman's University, the privilege of its facilities in order to study the following problem:

Compensatory controlled oxygenation and the level of consciousness in patients with traumatic head injury.

The conditions mutually agreed upon are as follows:

1. The agency (may) (may not) be identified in the final report.
2. The names of consultative or administrative personnel in the agency (may) (may not) be identified in the final report.
3. The agency (wants) (does not want) a conference with the student when the report is completed.
4. The agency is (willing) (unwilling) to allow the completed report to be circulated through interlibrary loan.
5. Other: Would like a copy [illegible]

Date 9/8/78

[illegible]
Signature of Agency Personnel

Diane E. Schull
Signature of student

[illegible]
Signature of Faculty Advisor

*Fill out and sign three copies to be distributed as follows: Original - Student; first copy - agency; second copy - T.W.U. College of Nursing.

TEXAS WOMAN'S UNIVERSITY
COLLEGE OF NURSING
DENTON, TEXAS

DALLAS CENTER
1810 Inwood Road
Dallas, Texas 75235

HOUSTON CENTER
1130 M.D. Anderson Blvd.
Houston, Texas 77025

AGENCY PERMISSION FOR CONDUCTING STUDY*

THE Hartford Hospital

GRANTS TO Diane Elizabeth Schull

a student enrolled in a program of nursing leading to a Master's Degree at Texas Woman's University, the privilege of its facilities in order to study the following problem:

Compensatory controlled oxygenation and the level of consciousness in patients with traumatic head injury.

The conditions mutually agreed upon are as follows:

1. The agency (may) (may not) be identified in the final report.
2. The names of consultative or administrative personnel in the agency (may) (may not) be identified in the final report.
3. The agency (wants) (does not want) a conference with the student when the report is completed.
4. The agency is (willing) (unwilling) to allow the completed report to be circulated through interlibrary loan.
5. Other: __________

Date Sept. 8, 1978

Dorothy [illegible] R.N. Dir. Nursing Ed.
Signature of Agency Personnel

Diane E. Schull
Signature of student

Barbara [illegible]
Signature of Faculty Advisor

*Fill out and sign three copies to be distributed as follows: Original - Student; first copy - agency; second copy - T.W.U. College of Nursing.

TEXAS WOMAN'S UNIVERSITY
COLLEGE OF NURSING
DENTON, TEXAS

DALLAS CENTER
1810 Inwood Road
Dallas, Texas 75235

HOUSTON CENTER
1130 M.D. Anderson Blvd.
Houston, Texas 77025

AGENCY PERMISSION FOR CONDUCTING STUDY*

THE Agency

GRANTS TO Diane Elizabeth Schull

a student enrolled in a program of nursing leading to a Master's Degree at Texas Woman's University, the privilege of its facilities in order to study the following problem:

Compensatory Controlled Oxygenation and the Level of Consciousness in Patients with Traumatic Head Injury

The conditions mutually agreed upon are as follows:

1. The agency (~~may~~) (may not) be identified in the final report.
2. The names of consultative or administrative personnel in the agency (~~may~~) (may not) be identified in the final report.
3. The agency (wants) (~~does not want~~) a conference with the student when the report is completed.
4. The agency is (~~willing~~) (unwilling) to allow the completed report to be circulated through interlibrary loan.
5. Other: The patient, physicians, personnel, nor institution names may be used in this study.

Date 11-7-78

J. Larry Reed
Signature of Agency Personnel

Diane E. Schull
Signature of student

[signature]
Signature of Faculty Advisor

*Fill out and sign three copies to be distributed as follows: Original - Student; first copy - agency; second copy - T.W.U. College of Nursing.

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