LEFT OR RIGHT, UP OR DOWN: A CASE FOR POSITIONING OF UNCONCIOUS HEAD-INJURED PATIENTS

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Abstract

Nursing care activities have been proved to cause increases in intracranial pressure (ICP) which could be detrimental to the patient's health. Because positioning is one of the activities that causes the greatest pressure changes it was evaluated in this study. Cumulative increases also occur when nursing care activities are carried out in quick succession. The analysis of the data and literature suggest that the backrest position with the head of the bed evlevated 30 to 45 degrees is the best position for a patient with increased ICP. If further research should prove that this position has a negative influence on the cerebral perfusion pressure, these recommendations will have to be revised.

Opsomming

Daar bestaan bewyse dat verpleegsorghandelinge 'n toename in intrakraniale druk (IKD) tot gevolg kan hê wat 'n nadelige effek op die pasiënt se gesondheid uitoefen. Aangesien posisionering een van die aktiwiteite is wat die grootste drukveranderinge tot gevolg het, was dit in die ondersoek geëleveer. Kumulatiewe drukstygings ontstaan wanneer verpleegsorghandelinge vinnig op mekaar volg. By die ontleding van die data sowel as die literatuur blyk dit dat die rugliggende posisie met die koppenent van die bed tussen 30 tot 45 grade geëvalueer die beste posisie vir die pasiënt met verhoogde IKD is. Indien dit sou blyk dat die serebrale perfusie druk negatief beïnvloed word deur hierdie pesisie moet hierdie aanbevelings egter hersien word.

INTRODUCTION

Nursing care activities have been proved to cause increases in intracranial pressure (ICP) which could be detrimental to the patient's health. During the past decade studies have appeared in the literature suggesting the negative or positive effects of various positions or nursing actions. In most textbooks on the nursing care of head injured patients it is suggested that the head of the bed be elevated between 30 to 45 degrees unless symptoms of shock are present (Sherry, 1982:31; Marshall & Bowers, 1982:314; Davenport-Fortune & Dunnum, 1985:368; Viquesney,1987:47). However, none of these authors take cerebral perfusion pressure into account. Could it be possible that although the ICP is being treated by the 'head up' position the effects on cerebral perfusion pressure (CPP) could in itself cause harm to the patient? Is it possible to give the correct nursing care to patients who have suffered severe head injuries without proper monitoring of the relevant haemodynamic parameters? As we are all aware, nothing can be done to reverse the primary brain injury, but it is important that everyone should try to limit secondary brain injury which is often worse than the primary injury. Due to fear of aggravating the injury nurses tend to keep 'hands off' so that no harm can be done. This does not mean it is the best option. Meticulous nursing care still forms the basis for quality nursing care which is essential for the patient's wellbeing.

One of the main factors associated with changes in ICP is the positioning of the patient. Patients need to be positioned in the best possible way without causing too much of an increase in ICP. The purpose of this study was to establish the best position for nursing of head-injured patients, as well as the best way to schedule repositioning in order to cause the least increase in pressure.

ICP will be described briefly to clarify the rest of the article.

INTRACRANIAL PRESSURE (ICP)

In 1977 the Richmond group examined 225 seriously brain injured patients and monitored their ICP. They found that 70% of the patients with brain lesions requiring surgery had increased ICP and that 30% of the group died as a result of the increased pressure. In patients with diffuse brain injury 33% had increased pressure, of whom four percent were uncontrolled. In the case of intracerebral contusions 70% of the patients had increased pressure, six percent of whom were uncontrolled. Of the patients who underwent surgery 50% continued to have problems with increased ICP (Ward 1986:398). Bruce et al (1981:170-178) reported a 59% incidence of increased ICP in children with serious head injuries.

It appears that patients with increased ICP have a poorer prognosis. Whether this can be ascribed to the increased pressure per se or to the magnitude of the primary injury is difficult to determine (Jennett and Teasdale 1981:127; Ward 1986:398).

However, it is important to stress that the ultimate consequences of a head injury are a combination of the primary injury at the time of the impact and the secondary injury caused by the increased ICP and various other complications. This is why it is important to avoid or limit secondary injury as far as possible at all costs.

PHYSIOLOGY OF INTRACRANIAL PRESSURE

Normal ICP usually varies between 0 and 10 mmHg (80-180 mm H_2O). A pressure of more than 15 mmHg is regarded as abnormal. The pressure oscillates during the respiratory and cardiac cycle, but these oscillations have no

clinical significance (Hickey 1981:143; Nikas 1982:30).

The brain is accommodated in a closed container with inflexible walls. The skull is filled almost to capacity with the brain parenchyma which occupies approximately 86% of the total volume, while the CSF takes up about 9-10% and the total intracranial blood volume approximately 5-7% (Jennett 1970:4). The ICP depends on a delicate balance between the brain tissue, CSF and intracranial blood volume. An increase in volume of any of the three components must be at the expense of the others, otherwise the ICP rises. There are, however, compensatory mechanisms which can accommodate slight changes.

The theoretical volume-pressure curve gives an indication of the compliance or compensation that may be allowed. (See Figure 1). An initial increase in intracranial volume (ICV) does not cause a rise in ICP. A slight pressure increase does, however, begin to occur at a certain level of unit volume increase (a). A considerable pressure increase occurs later, even if the unit of volume increase remains constant (b). The flat part of the pressure curve reflects the compliance of the brain where volumes can compensate and the pressure can be kept constant. The sharp rise in pressure reflects the decompensation phase in which slight increases in volume cause dramatic pressure increases (Nikas 1982:30).

The brain demands a constant blood flow to function effectively. Cerebral blood flow usually remains relatively constant and depends on cerebral perfusion pressure (CPP). CPP is the difference between the mean arterial pressure (MAP) and ICP (CPP = MAP - ICP) and varies between 80 and 100 mmHg (Nikas 1982:54). CPP should not drop below 50 mmHg since

functional changes set in when it drops below 40-50 mmHg (Nikas 1982:33). A CPP of 30 mmHg is incompatible with life and leads to neural hypoxia and cell death (Hickey 1981:144).

The interaction between CPP and ICP is very complex. A rise in ICP can, for instance, cause a drop in CPP, while a primary increase in CPP as a result of vasodilatation, can cause a rise in ICP. A critical point is reached when the ICP is within 40 mmHg of MAP because cerebral blood flow diminishes as the CPP declines (Jennett 1981:55).

An analysis of findings reported in the literature will be given to determine the influence of positioning on ICP.

META-ANALYSIS OF THE LITERATURE

Mitchell (1980:150) found that very little systematic research had been done on ICP and the factors that influence it. Although there are a number of anecdotal reports on specific incidents, qualitative and quantitative pressure increases and stimuli frequencies are seldom found in the literature. A number of researchers have published anecdotal reports on aspects that influence ICP since Lundberg (1960:193) found that physical activities and emotional outbursts lead to plateau increases. The relationship between head rotation and positioning and ICP has often been studied but never quantified.

One of the first systematic research reports on nursing care activities and ICP appeared in 1977. Shalit and Umansky reported on pressure changes that occur during positioning. In this case, too, the duration and quality of the increases were not investigated (Shalit and Umansky, 1977:881-886).

In 1978 Mitchell and Mauss (1978:4-10) studied factors that influence ICP. They used CSF drainage through a ventricle catheter as an index of ICP and, therefore, could not also measure the quality of the increases. They found that activities such as repositioning were almost always associated with CSF drainage, while passive movement almost never led to CSF drainage unless it occurred simultaneously with the former activities (Mitchell, 1980:150).

Mitchell et al. (1980:565-568) conducted a further study in 1980 about aspects such as passive movement, turning and head rotation and ICP. They found that the pressure rose after a change of position in 88 percent of cases and that the duration of the increase was 5 minutes. A further finding was that activities performed at 15 minute intervals resulted in a cumulative pressure increase, but that that this did not occur if an hour elapsed between repositionings. Head rotation also led to pressure increases (Mitchell, 1980:150,151).

Weed demonstrated as early as 1929 that ventricular fluid pressure in dogs dropped with elevation of the head and rose when the head was lowered. Nornes and Magnaes found in 1971 that neck flexion, hip flexion, the supine position and 90 degrees head rotation consistently resulted in increased ICP. This corresponds with studies by Hulme and Cooper (1977) and Shalit and Umansky (1977). Lipe and Mitchell (1980) believe that an elevated ICP is caused by a drop in venous outflow, Valsalva's manoeuvre and obstruction of CSF outflow from the basal cisterns (Goldberg et al., 1983:428-439; Mitchell, 1980:151; Mitchell, Ozuna and Lipe, 1981:213).

Parsons and Wilson studied changes of position. In 200 observations they found that all position changes, with the exception of elevation of the head, were accompanied by an increase in heart rate, mean arterial blood pressure, mean ICP and cerebral perfusion pressure (1984:68-75). These findings concur with those of a study by Boortz-Marx (1985:89-94).

Maximum increases in ICP were observed by Hulme and Cooper (1976:259) during neck flexion, bilateral jugular vein obstruction and head rotation to the right if the baseline pressure was above 10 mmHg. This may indicate that this group of patients had high brain elastance and that they were, therefore, more susceptible to venous outflow obstruction and volume increase.

Lipe and Mitchell (1980:1036) found that the left lateral position resulted in greater pressure increases than the right lateral position. This tendency is ascribed to anatomical differences. The left internal jugular vein is often anatomically smaller than its right counterpart, thus increasing its risk for potential obstruction. Furthermore, the left internal jugular vein joins the left subclavian vein at right angles to form the brachiocephalic vein, while the right

Figure 1
Theoretical volume-pressure curve.

Intracranial pressure

b

a

Intracranial volume
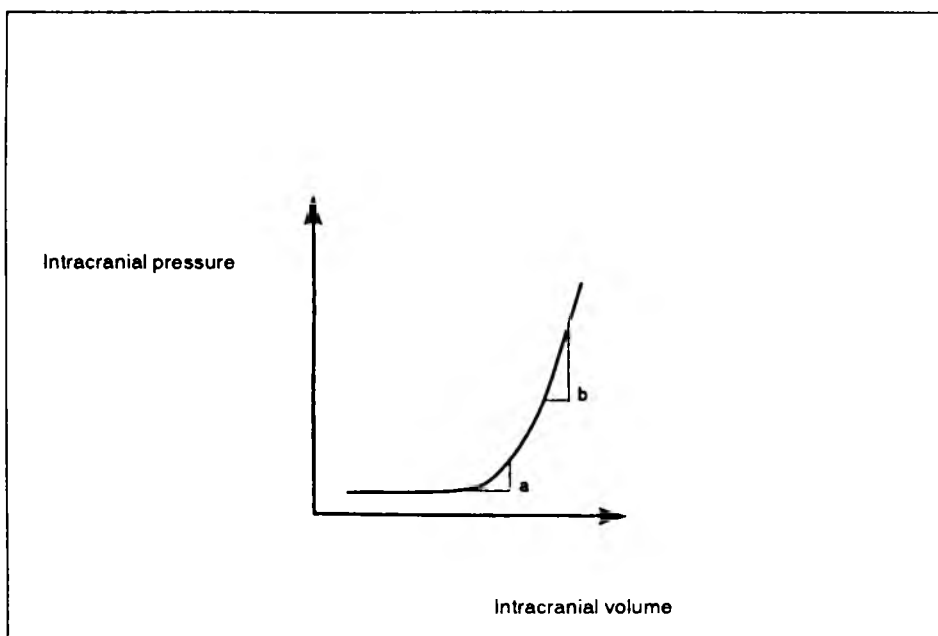
junction forms a blunt angle (Romanes, 1964:919). The findings of Lipe and Mitchell correspond with those of Hulme and Cooper, that is, that rotation to the right, especially at an angle of 90 degrees, causes greater pressure increases, particularly if the baseline pressure is above 10 mmHg.

Fuller (1982:60,61) observes that Parsons used a soft cervical neck brace as a protective measure for patients with a tendency to ICP increases during positioning, with very positive effects.

Mitchell recommends that nursing care measures be planned with great care for patients with an elevated ICP, high elastance and who have exhibited pressure increases after previous actions, as any further actions are sure to cause pressure increases. She particularly advises a conservative approach to patients whose pressure is not monitored, but who run a high risk of intracranial hypertension, since clinical signs are not a reliable and sensitive reflection of ICP. The left lateral position should be used with the utmost caution. The advantages and disadvantages of head rotation during bronchial toilet should be carefully weighed especially in view of the fact that this rotation causes pressure increases (Lipe and Mitchell, 1980:1036; Mitchell, 1980:151-153); (Mitchell et al., 1981:218).

Another aspect investigated was the influence of rest on ICP. Mitchell (1980:150) observed cumulative pressure increases when procedures were conducted at 15 minute intervals. Bruya conducted a similar study in which she allowed 10 minute rest periods before every procedure. She also found that a ten minute period of complete rest made no difference and that pressures continued to rise cumulatively (1981:184-194). Mitchell, on the other hand, found a significant difference if patients rested for at least an hour because the pressure had sufficient time to return to the baseline (1980:217). Although it is often difficult to allow patients in critical care units to rest for an hour, these findings stress the fact that careful nursing care planning can contribute to better control of ICP (Mitchell, 1980:153).

Shalit and Umansky (1977:886) even go as far as to claim "that the cumulative effect of increases in intracranial pressure which take place during routine management of these patients may be a major factor in determining the outcome of the illness".

Researchers could find no statistically significant effect on oxygen saturation and heart rate when they studied the influence of repositioning and lateral and supine positions with the head of the bed elevated at an angle of 20 or 40 degrees (Noll and Fountain, 1990:243-251; Shively, 1988:51-59; Clark, Winslow, Tyler and White, 1990:557-561). Winslow et al. reported transient increases in heart rate and a decrease in mixed venous

Table 1
Influence of specific body positions on ICP: Meta-analyses of literature.

AUTHOR	NUMBER OF SUBJECT	BODY POSITIONS	EFFECT ON ICP
Weed (1929)	39 dogs	head up head down	down up
Nornes & Magnaes (1971)	14 patients	sitting (neck and hip flexion) prone	up up
Hulme & Cooper (1976)	18 patients	neck flexion head rotation bilateral jugular compression	up
Shalit & Umansky (1977)	21 patients	turning head rotation	up or down up
Magnaes (1978)	4 patients	sitting return to lying	down up
Mitchell & Mauss (1978)	9 patients	turning	up
Mitchell et al (1981)	18 patients	turning head rotation	up or down up
Snyder(1983)	9 patients	turning	up
Parsons & Wilson (1983)	18 patients	turning head up head down	up down up
Goldberg et al (1983)	26 patients	head up head down turning	down up up
Boortz-Marx (1985)	4 patients	head rotation turning head up	up up down
Hugo (1988)	23 patients	head up head down turning head rotation	down up up up
Lee (1989)	30 patients	head up head down head rotation	down up up
March et al (1990)	4 patients	flat backrest head up	up or down up or down

oxygen saturation which gradually returned to baseline levels during the following four minutes. They state that should turning trigger large or prolonged changes in mixed venous oxygen saturation or heart rate, prompt repositioning and evaluation are needed to prevent adverse effects.

It seems that neither repositioning nor possibly either of the lateral positions have a significant influence on any of the other haemodynamic parameters, but these should nevertheless be carefully applied to patients with elevated ICP (see Table 1).

March et al. (1990:375-381) found that cerebral perfusion pressure is lowered in some patients by elevating the head of the bed, even though it has a positive effect on the ICP. Although the findings did not occur consistently in all

patients, it may be a factor which demands further research.

METHOD AND DESIGN

A descriptive, non-participant, empirical observational study was undertaken in a neuro-surgical intensive care unit (N-ICU) to establish the effect of positioning on the ICP of severely head-injured patients. A head injured patient with a coma scale count of eight or less, loss of consciousness of longer than six hours and/or an abnormal computer tomographic scan is regarded as seriously head-injured (Jennet et al. 1977:292). In the selected research unit measuring the ICP by means of an epidural pressure monitor or a ventricular catheter was standard protocol.

The field work of the study was conducted over a six month period and included twenty-three patients admitted to the selected N-ICU, who satisfied the following criteria:

* Severe head injury

* Glasgow Coma Scale score of 8 or less

* Unconscious for longer than six hours after the impact injury

* Abnormal CT-scan

* Signs of increased ICP

* No hypoxic injuries

* ICP monitoring with an epidural transducer for not less than twelve hours.

Patients whose ICP was monitored for less than a 12 hour period were omitted from the study. However, the initial twelve hours were part of the 72 hour study monitoring period. The variables studied were positioning and repositioning of the patient in the left lateral, right lateral, supine, and head of bed elevated 0, 15, 30 or 45 degrees and their effect on the ICP. The various factors that influence ICP will be discussed in further articles. However, all the patients were intubated and mechanically ventilated as part of the treatment protocol for elevated ICP.

As a non-participant observer the researcher did all the observations and monitoring of the patients over a 72 hour period following admission to the N-ICU.

DATA-ANALYSIS

The patients' positions were changed every two to four hours. Conventional hospital beds, the heads of which can be turned up were used in the research unit. Whenever possible patients were turned by at least two nurses standing on either side of the bed. The log rolling method was followed throughout to turn the patients onto alternate sides. The various treatment regimes and other variables were taken into account. Each patient's mean ICP, mean pressure increase (maximum ICP minus mean ICP) and the duration of the pressure increase was measured during the 72-hour period. Three hundred and sixty-nine events of positional changes were observed. The mean base-line ICP was 13,48 mmHg, the mean pressure increase 15,70 mmHg and the duration of increase 6,34 minutes. This means that the mean peak pressure obtained was 29,18 mmHg. (Peak pressure refers to the highest ICP occurring during a nursing intervention and is synonymous with maximum pressure, but is used to prevent confusion between maximum pressure and maximum pressure increase.) The maximum pressure increase observed was 39,18 mmHg which means the peak pressure could have been as high as 52,66 mmHg. These are dangerous increases in the already

compromised patient and should be avoided. (See Table 2.)

The data were subjected to the Fisher-exact-test in order to determine the relationship between the mean pressure and the duration of the pressure increase. A distinction was made between pressures of more and less than 15 mmHg, and between a duration of increase of more and less than 10 minutes. Possibly due to the sample size, no statistically significant difference could be demonstrated. This test was done to determine whether patients with increased ICP (mmHg) are more apt to plateau increases (10 min). The findings from the available data seem to suggest that patients with increased ICP are more apt to plateau increases while those with pressures within normal limits are more likely to have peak increases (see Table 3)

Repositioning is usually done during or after a bedbath or back care. This could cause a cumulative increase and duration of increase, which could have a detrimental effect on the patient's ICP, as reported by Mitchell (1980:150).

Most of the patients were positioned with the head of the bed elevated 45 degrees. Patients were repositioned every two to four hours by changing their positions to backrest, left or right

lateral. The data were analysed to ascertain which position caused the smallest baseline pressure difference. In the analysis the mean baseline pressure difference for each patient for each positional change was calculated. Thereafter the mean baseline pressure difference for each positional change was calculated. These results are summarized in Table 4 and displayed in Figure 2 (a,b,c).

It would seem as though the greatest pressure differences were obtained when the patients were turned to the left lateral position (X = 2,38; max = 16,00). These results correlate with those of Lipe & Mitchell (1980:1036).

The Fisher-exact-test was performed on the data to determine whether there was a correlation between the frequency of nursing care activities and the duration of increase. In this case a comparison was made between two or more nursing care activities during one hour or less and a duration of increase for more or less than 10 minutes. A statistically significant correlation was established where more than two nursing care activities occurred within one hour and a duration of increase longer than 10 minutes (p = 0,018).

Spearman- correlations were calculated between duration of increase and ICP-increase in one hour. In most cases a stasitically

Table 2
Mean Pressure Increase and Duration of Increase associated with Repositioning

Observations	Mean baseline ICP	Mean pressure increase (mmHg)	Mean peak pressure (mmHg)	Mean duration of increase (min.)
369	13,48	15,70	29,18	6,34

Table 3
Relationship between mean ICP and duration of pressure increase.

FISHER-EXACT-TEST			
Action	Duration (minutes)	Mean ICP (mmHg)	
		≤ 15 mmHg	≥ 15 mmHg
Repositioning	≤ 10 > 10	18 (90%) 1	2 2 (67%)

Table 4
Mean Baseline Pressure Difference associated with Repositioning

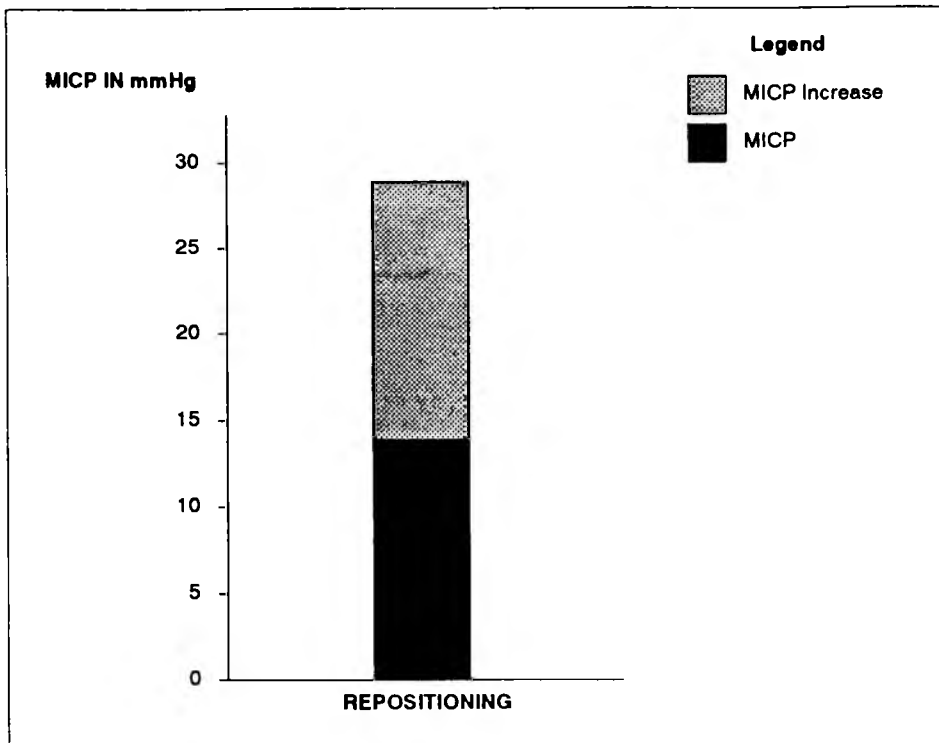| POSITIONAL CHANGE	MEAN BASELINE PRESSURE DIFFERENCE	MIN	MAX
1. Left lateral to back	-0,53	-7,71	11,00
2. Back to left lateral	2,38	-2,00	16,00
3. Right lateral to back	-0,72	-12,00	5,50
4. Back to right lateral	0,53	-3,00	5,00
5. Left lateral to right lateral	-1,21	-8,50	3,00
6. Right lateral to left lateral	1,11	0,00	3,33

FIGURE 2 (a)
Mean ICP increase associated with Repositioning
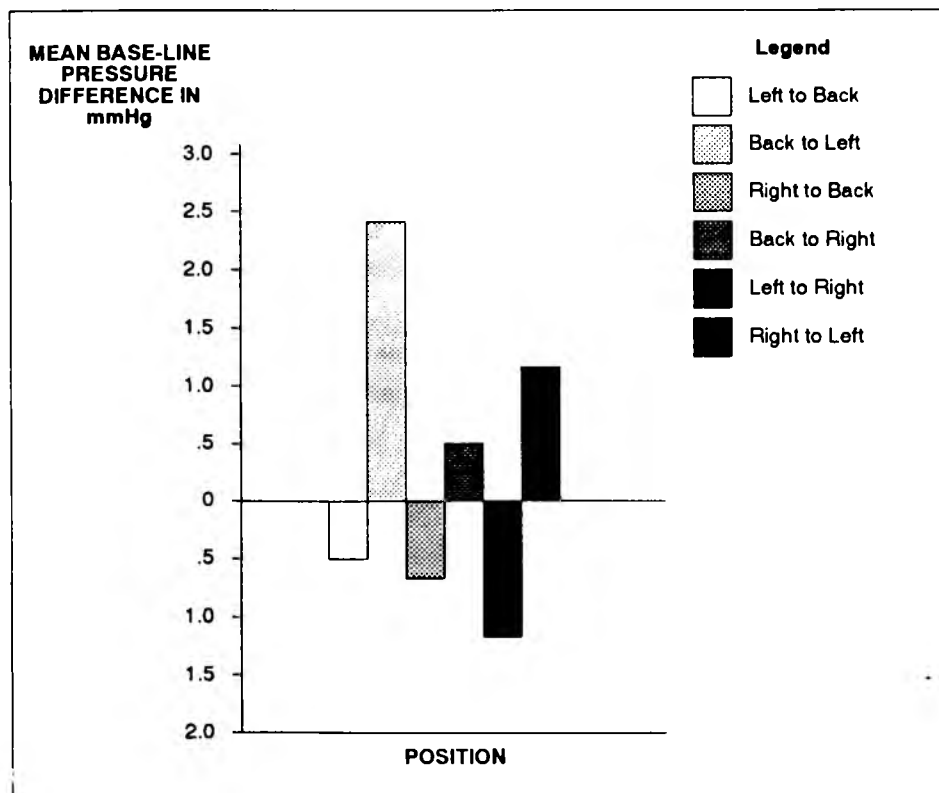

FIGURE 2 (b)
Mean Base-line Pressure Difference associated with Repositioning

significant correlation was established (p 0,05). When the mean for ICP-increase, duration of increase and frequency of activities were calculated, a significant correlation between duration and frequency could be established (p = 0,04), but it could not be established for mean ICP-increase and duration of increase (p = 0,55). A larger sample might have produced different results.

A statistically significant difference was established with the Mann-Whitney-test where two or fewer activities occurred in one hour and those in which more than two occurred when compared to the duration of increase (p = 0,007).

Careful planning of nursing care activities is therefore, of the utmost importance to ensure

quality nursing care with the least negative influence on the ICP of head injured patients.

CONCLUSIONS

The repositioning of severely head-injured patients should be planned carefully in order to limit pressure increases to the minimum. Individual patients' pressures should be analyzed to establish sensitivity with regard to brain elastance. Positions that are not well tolerated by a particular patient should be avoided or if unavoidable allowed for only a very brief period.

In summary, the data show:

* Best position :
  Supine with head of bed elevated between 30 - 45 degrees

* Best positional changes :
  left lateral to right lateral
  left lateral to back
  right lateral to back

* Worst position :
  left lateral
  head of bed not elevated

* Worst positional changes :
  back to left lateral
  back to right lateral
  right lateral to left lateral

The data obtained from the research and literature shows that the ICP of patients with severe head injuries should be monitored in order to evaluate and apply specific treatment modalities. Monitoring the ICP is important to nurses as it provides valuable information for optimum nursing care planning.

The scheduling of nursing interventions forms the basis of planning. If the patient has high brain elastance and is inclined to frequent peak and plateau increases, unnecessary nursing actions should be scheduled at longer intervals.

Nursing interventions that have a negative influence on the ICP should not be performed together or successively. Since a bedbath, repositioning, bronchial toilet and mouth toilet often cause significant ICP elevation, these procedures should be carefully scheduled and should not all be performed in quick succession as this will have a cumulative effect on the ICP. It is important to record the particular positions or nursing actions to which the patient is most sensitive, in order that all the members of the health team may consider them when performing procedures. Although the best position recommended at present is one in which the head of the bed is elevated at an angle of 30-45 degrees, future research may yet prove the contrary.

Monitoring the ICP does not depend only on the observation of an average baseline pressure. It is absolutely essential that nurses evaluate the
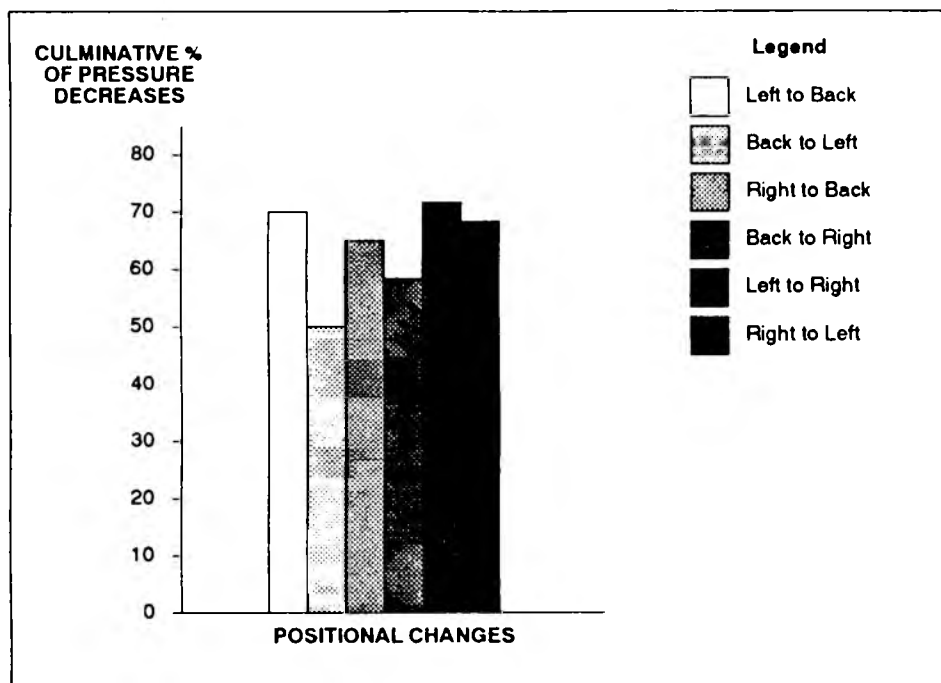
FIGURE 2 (c)
Base-line Pressure Differences associated with Positional Changes

quality and quantity of ICP increases. This allows them to form an impression of the degree of compliance of the patient's brain in order that they may plan the treatment protocol accordingly. The most important aspect, and this cannot be sufficiently stressed, is that the scheduling of patient care is determined by the patient and not by the nurse.

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