

# The cost of head injuries

Medical, emotional, financial and social

— Q du Toit



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## Curriculum vitae

Dr Du Toit is a clinical psychologist at Groote Schuur Hospital, Valkenberg complex and senior lecturer in the Department of Psychiatry at UCT. She works clinically in the Department of Neurosurgery and Radiotherapy, and has an interest in brain-damaged and dying patients. She has published various articles as well as books, one for the family of the dying patient and another for the dying patient himself. Dr Du Toit is married to Ds HD du Toit, clinical pastor at the Theological Seminary, Stellenbosch. They have 4 children; the eldest daughter is a medical intern at Tygerberg Hospital. Over weekends she does marriage enrichment courses with her husband, and in her free time likes to read, do sculpting and look after her family.

With thanks and appreciation to Prof JC de Villiers, Dept Neurosurgery, UCT, co-researcher in this project.

**KEYWORDS:** Head injuries; Patients; Costs & cost analysis; Economic value of life; Social adjustment; Emotions; Accident, Traffic; Trauma; Personal expenditure

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## Summary

*This is a prospective study into the global cost of brain injury in a group of white adults with at least a Standard 10 education, admitted to Groote Schuur Hospital over a period of 2 years. The different kinds of injuries are described as well as the medical, emotional, financial and social costs involved.*

Over the centuries mankind has tried to understand the functions of the brain. From the ancient Greeks who saw it as a radiator to cool the blood, to modern man who tries to explain its functions by comparing it to a computer. Yet, every explanation remains inadequate 'for the brain is unique in the universe, and unlike anything man has ever made.' (Robert Ornstein)

'The brain regulates all bodily functions, it controls our most primitive behaviour - eating, sleeping, keeping warm. It is responsible for our most sophisticated activities - the creation of civilisation, of music, art, science and language. Our hopes, thoughts, emotions and personality are all lodged somewhere - inside the brain. After thousands of scientists have studied it for centuries, the only word to describe it remains "amazing". There are one hundred billion neurons (nerve cells) in the brain, and in a single human brain the number of possible interconnections between these cells is greater than the number of atoms in the universe.' (From: *The Amazing Brain*).

Brain injury of any degree disturbs the unique dynamic integration of this biological machine. Reintegration takes time and in many instances may never totally happen again. The cost to the individual in terms of diminished potential, changes in lifestyle, financial loss and in many other ways is great.

This is a provisional report on a prospective study into the global cost of brain injury in a group of young white adults who have had at least a Standard 10 education and who were admitted to the Groote Schuur Hospital, Neurosurgical Unit over a period of 2 years. This particular group constitution was chosen to investigate, as far as possible, a homogeneous group. A Standard 10 education was decided on to ascertain a premorbid intellectual function of at least a Normal to Above Normal range. They were all between 17 years and 35 years of age to assure that deterioration due to natural ageing played no part in the results.

On admission patients falling into the research group (RG) were totally clerked and followed up

daily to monitor progress. A personality profile was obtained from the next of kin within the first 3 days after the injury and again at 6 months and 12 months post injury and where possible 2 years after the injury. As this is a provisional report only part of the total research group (RG) has already been followed up this long. Assessments carried out on the patients themselves were as follows:

1. They were assessed with a battery of neuropsychological tests at 6 months, 12 months and 2 years post injury. The battery included the WAIS\*, Williams test (for delayed visual recall), the Francis Hemp Shopping list (for delayed auditory recall), the Trail Making Test\* and the Passat\*.
2. All had intensive psychiatric interviews at 3 months, 6 months, 1 year and 2 years post injury.
3. A CT-scan, MRI\* and EEG is in the process of being performed on all RG members, for which the results are not yet available.
4. Finally a 'Cost Questionnaire' was completed at 1 year and 2 years following injury. The financial costs were calculated according to medical aid fees, as it was felt that the cost is at least the same for the Provincial Hospital, which has to supply all the services a private hospital offers.

### Characteristics of the research group (RG)

During the period 1 June 1984 to 31 May 1986 a total of 2442 patients were admitted to the Neurosurgical Unit at Groote Schuur Hospital. Of these, 742 were head injuries (excluding stabs in the head) which amounts to 30% of all patients.

Of these, 81 patients were included in the research group, which amounted to 11% of all head injuries.

### *Road traffic injuries were the main cause of head injuries - and very few were pedestrians.*

There were 106 patients who died of head injuries of which 22 were in the research group.

A total of 141 head injuries (HI) fell within the severe group - 19% of all head injuries - of which 26% were in the research group.

A total of 21% of HI fell within the minor-mild group, and 14% of this group were included in the research group.

Where 16% of all head injuries (HI) had depressed fractures only 3% were in the RG. The main reason for this was that only a few patients in the group were assaulted.

The base of skull fractures and the haematomas had the same ratio in both groups.

Missile injuries, however, were 4 times as high in the RG as in the total HI group. They made up 2% of all head injuries of which 11% were in the research group.

In the research group of the 55,5% who were students, 19% were medical students. This high ratio is unexplained as all the accidents happened over weekends and thus presumably were not due to fatigue. The average age in the severe group was 24,3 years and in the minor-mild group 22,9 years.

In the severe group 73% were males and in the minor group 70% were males.

It thus seems that it is mainly the student male population in their early twenties that made up the research group. The importance of this group to the future of the country need not be stressed here. We cannot afford to lose this potential in manpower in a small country like ours.

### Cause of injury in the RG (research group)

Table 1: Cause of head injuries (survivors) in research group

	Severe	%	Minor-mild	%
Road traffic injuries	32	84	10	45
Falls	4	11	6	27
Sports	0	—	4	18
Missile wounds	1	2,5	—	—
Assaults	1	2,5	1	5
Others	—	—	1	5

In both the severe and minor-mild group road traffic injuries were the main cause of head injury. In the severe group 84% were in this group, where 45% in the minor-mild group were caused by road traffic injuries. Falls amounted to the second highest cause, especially mountain falls which is understandable in the Cape where mountain climbing is a favourite pastime of young adults.

If we look at the breakdown of accident causation, it is interesting to note that most of the road traffic injuries were sustained by drivers and that very few pedestrians were involved.

All motor cycle injuries were in the severe group, whereas the sports injuries were mostly in the minor-mild group. The most bizarre accident was one of a young man being injured by the elbow of a fellow disco bouncer.

### Medical costs of acute care

Before going into detail, we want to point out what a few ordinary procedures cost, e.g. to keep a person in an ICU, is R168,50 per day and R113,00 in a neurosurgical high care ward. If the same patient is cared for in an ordinary orthopaedic ward R11,00 per day can be saved. The cost for a patient with a resistant staph in the tracheostomy ward is R115,00 per day where it will be R50,00 less in the staph unit. Every day on a respirator adds another R66,50. In the ICU Astrups are done routinely at

**Table 2:** Medical cost of severe head injuries

Hospitalisation	A		B		C	
	Cases without other injuries		Cases with other injuries but no complications		Severe with complications	
	Mean		Mean		Mean	
	R	c	R	c	R	c
ICU	840,00		1 516,50		1 685,00	
High care ward	452,00		1 130,00		2 147,00	
Neurosurgery ward	1 170,00		2 028,00		2 652,00	
Radiology	280,60		1 286,00		623,50	
Other investigations	43,40		484,00		2 313,40	
Referrals	476,00		775,00		825,00	
Paramedicals	1 120,00		1 227,00		2 337,50	
Medication	392,80		1 109,64		2 894,38	
OPD	150,00		150,00		200,00	
Surgical procedures			1 145,00		773,80	
<b>Total</b>	<b>4 924,80</b>		<b>10 851,14</b>		<b>22 332,58</b>	

R19,40 each. One patient in the RG had 48 Astrups performed on him. A SMAC\* costs R136,00 but if individual tests are asked for, it drops to R19,60 per test.

A CT-scan costs R195,20 and although this is a life-saving test, it can shoot up the cost in an individual case tremendously. Another hidden cost riser is the chest X ray at R37,60. Medication (especially antibiotics) is another culprit, e.g. Fucidin costs R160,17 for 36 tablets. Erythromycin is R23,21 for 1 amp., and Mandoceph is R81,84 for 1 amp., to mention but a few. The difference between Phenytoin at R19,25 and Carbamazepine at R54,78 per 100 is self-explanatory. The feeding of an unconscious patient amounts only to about R6,28 to R10,14 per day. Blood, especially frozen plasma at R33,00 per unit can, however, increase the cost.

It is noted that fresh blood products are always more expensive than frozen blood products.

In the severe group, we have looked at:

- A. cases without other injuries or complications,
- B. cases with other injuries and
- C. cases with complications.

If one looks at the mean scores of these 3 groups the following is observed:

- (i) The cost rises significantly if any other injury is present.
- (ii) The cost is nearly 5 times as high with complications than with a straightforward severe injury.
- (iii) There is an increase in mean hospitalisation cost from group A to B to C from R2 462,00 to R4 674,50 to R6 484,00.
- (iv) In group B the main increase is in surgical procedures, radiological investigations and medication.

- (v) Group C's main cause of cost increase is in other investigations, paramedical cost (particularly physiotherapy) and medication, twice as high as group B and 7 times as high as group A.

## *A student population in their early twenties make up this research group - a significant loss for our country.*

It thus seems that a severe head injury without other injuries or complications does not account for the major cost involved in head injury treatment, but that any other injury or a complication, especially infection, escalates the cost significantly.

It needs to be mentioned again that this is only the cost of the acute medical treatment. Rehabilitation, for which at present there are no real facilities, and long-term chronic care, have not been included in this estimation of costs.

In addition the cost in travel and loss of work hours of family members still have to be added. On the average at least one member of a family did not work for an average of 8,7 days in a severe injury. If this is calculated at at least R10,00 loss of income to the country per hour, it amounts to R696,00 per severe injury. This is a conservative estimate as in more than one case highly skilled people took off much longer to be with the injured patient.

The projected income loss for the severe group is between R125 000 and R1,6-m per patient. This was calculated by a reliable insurance company.

## Outcome

Table 3: Glasgow scale

Glasgow Outcome Scale	Glasgow Coma Scale on Admission			
	Severe	%	Minor-mild	%
Dead	20	—	2	—
Vegetative	1	3	0	—
Severely disabled	6	16	0	—
Moderately disabled	21	57	0	—
Good recovery				
- same level	2	5	15	59
- lower level	7	19	9	41
<b>Total</b>	<b>57</b>	<b>100</b>	<b>24</b>	<b>100</b>
<b>Survivors</b>				
- Not working	18	49	—	—
- Working/studying in any field	19	51	22	100
<b>Total</b>	<b>37</b>	<b>100</b>	<b>22</b>	<b>100</b>

Of the severe group, only 5% were functioning on the same level as before, another 19% had a good outcome in the sense that they were still functioning reasonably well, but on a lower level, e.g. changing their studies from a degree to a diploma course. Initially, 68% of the severe cases were either studying or back at work, but this dropped to 51% at one year post injury. It might seem high that 51% of this group is still employed or studying, but most of them are moderately disabled and earning less than before, or not progressing in their studies at all.

It is also significant that in the mild to moderate group, 41% were functioning on a lower level than before. Nevertheless, they all made a reasonably good recovery and were all employed or studying.

At present it seems that a general depression of the WAIS at first testing indicates a poorer prognosis rather than an uneven scatter where some tests hold at the premorbid level. This is probably due to a more diffuse injury. This tendency will be followed up over a longer period.

Of all the tests the Passat seems to be the best indicator of the patient's readiness to return to work and to function under stress. In a few cases all the other tests indicated that the patient would be able to function in his previous position but the Passat - especially at the 1,2 sec. - indicated that the patient was still slow and this correlated with poor work or study adjustment.

In the severe group on the preliminary results, a lowered mean IQ score of 18 points from premorbid to post-injury scores was elicited. This is of great importance as it points to the importance of the

premorbid level of functioning in predicting the outcome of a severe injury.

The scatter pattern on the WAIS depended greatly on the locality and the kind of injury - diffuse or localised - the patient had. However, it seems that in all cases the subtests mostly depressed were Arithmetic, Object Assembly, Blocks and Digit Symbol. The Digits forwards was often not affected, whereas the Digits backwards were.

Some of the severe group tested with a Normal to Above Normal IQ but could not function as a result of specific areas of deficiency resulting from the brain injury such as:

### a) Language disturbance

(i) *Speech changes* like slow, slurred speech or over-talkativeness or tangentiality have caused patients to appear of lower intelligence than the level at which they are actually functioning. Two patients were rejected from a university course as a result of slow speech.

(ii) *Word-finding problems* of different degrees often pose a problem.

### b) Concentration

Initially this was a problem in all the cases, both mild and severe.

*The projected income loss of a severe head injury is between R125 000 and R1,6 million per patient.*

### c) Memory

Memory is a complex function and thus is affected differently in every brain-injured case. Nevertheless, all the patients initially complained of short-term memory problems and in 37% of this group it remained a problem after 6 months.

### d) Other odd disturbances

(i) Inability to recognise faces before the person talks, in a girl who had been unconscious for 3 months and who is now back at university.

(ii) Body sensation problems like perceiving somebody following them or a presence next to them or a misplacement of some part of the body.

### Emotional cost

Most of the minor-mild group complained of anxiety and even panic attacks after the accident whereas the severe group did in most cases not experience this anxiety as their insight into their ability to function was initially poor. In the minor group they all initially complained of emotional lability and irritability. In most of these cases this

**Table 4:** *Sleep patterns*

Severe			Minor-mild		
More	Same	Less	More	Same	Less
21	6	10	10	7	5
57%	16%	27%	45%	32%	23%
Two patients changed sleeping pattern from night to day.			One patient changed sleeping pattern from night to day.		

changed after about 6 months to their premorbid state. In the 5 cases where these problems continued an examination into their premorbid personality showed a very anxious dependent-like pattern. This group visited the psychologist on an average of 2,4 visits after discharge from hospital. The severe group showed a greater degree of personality change with a more permanent result. The main changes for the group as a whole were on the one hand those who became quieter and more withdrawn and those who became more irritable, impulsive and aggressive.

*Speech disturbances have often caused patients to appear of lower intelligence than the level at which they are actually functioning.*

Sleep pattern changed in both groups. Most complained of sleeping more and feeling drowsy during the day. This very often is not a true change in sleep pattern but rather hypo-arousal, whereas they can stay awake when their attention is held. This remained a long-term problem for the severe group where in the minor group it improved after a year. The initial complaints in both groups were fatigue, slowness, poor concentration and memory, impulsiveness and irritability. After a year the greatest remaining problem in the minor group was a poorer memory than before the injury. In the severe group 70% still complained of memory problems, fatigability, poor concentration, irritability and impulsiveness. These symptoms were perceived by the family as bad-tempered and as reflecting poor emotional control (Table 4).

### Social cost

A family functions as a unique unit, in some ways similar to other families, but in others quite differently. The haemostasis in some families is more precariously balanced than in others and this will influence reactions to a crisis or to stress. The severity of a head injury and the outcome are factors that influence the severity of stress symptoms a family will exhibit after a head injury. In this group most of the patients were still part of

their families of origin or part of a young, new family.

In all the cases the families' first reaction was that they wanted the patient to live, no matter how severely he was injured or how dependent he was going to be. It was only after about 6 months, when the family realised that the patient was a changed person, that they started rejecting the patient or that they became aggressive towards the fact that it had happened. Families of origin more easily accepted the patient than wives. Some mothers even initially enjoyed having their child back as a 'baby' totally dependent on them and had problems separating from the child later on. This may be a problem in rehabilitation. At the same time, in many cases, it was the mother who believed that her child would recover again and constantly supported him. This is a factor of considerable importance and difficult to measure.

*When the brain of a person is injured, it has a rippling effect through families, communities and in the end touches every taxpayer's pocket.*

In the severe group 63% lost all their friends and 42% of their marriages broke up. Of the parents 74% reported diminished sexual functioning in the first 6 months after the accident. Of the mothers 51% were significantly depressed enough to receive treatment. The wives reported an inability to accept a totally changed person. This had a severe influence on their way of relating both emotionally and sexually to their husbands. Of the wives 79% suffered from depression and guilt feelings. They felt aggressive towards their in-laws who they thought were over-protective to the injured patient.

As the children in this group are mostly small, it is difficult to ascertain the influence on them although the parents who were questioned, did report tension symptoms like over-dependency, bedwetting and unnecessary crying in the young children.

### Conclusion

As this is only a preliminary report a number of factors still have to be analysed.

From the results we already have, we however, know that when the brain of one person is shattered, it has a rippling effect far wider than that single person. It reverberates through families, communities and in the end touches every taxpayer's pocket. Every person using a car, crossing a street, playing a game or walking on the mountain is at risk to be the next brain-injured patient. Every person and every family perpetually carries the potential hazard of bearing the burden of such an enormous cost.

### Bibliography

Ornstein R, Thompson R. The amazing brain. London: The Hogard Press, 1985.

### \* End notes

*WAIS*: Wechsler Adult Intelligence Scale

*Trail Making Test*: Tests mental set and mental shift needed to adapt old knowledge to a new situation

*Passat*: Tests ability to function under stress; also tests mental shift under stress as required in work situation

*SMAC*: A battery of blood chemistry tests

*MRI*: Magnetic resonance imagery; more diagnostic of brain tissue disruption than the CT-scan.

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Reference: Brühl, P., et al. Dtsch. Med. Wschr. 104 (1979) 1236.

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