A survey of spinal injuries from diving
A study of patients in Pretoria and Cape Town

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Summary
A highly significant feature emerged from a study of patients with spinal injuries from diving treated at the H. F. Verwoerd Hospital and the Conradie Hospital, namely an area specificity with regard to cause of injury, circumstances and social habits.

The typical patient presenting with spinal injuries from diving is a young male, the injury often being the result of the facing of a 'challenge' at a social gathering where alcohol consumption played an important role. The injurious dive is usually not a first attempt and is often into a pool of some sort or at a location well known to the patient. The forehead or vertex may strike either the bottom of the pool, a rock, or a sandbank, without any additional injuries, e.g. to the hands. The radiographs reveal a flexion-axial compression injury to the C4-C6 region of the spine, leaving the majority of such patients in a state of permanent and complete tetraplegia.

Although many of these catastrophes are truly accidental, a large number of patients admit to a careless attitude which was the direct cause of their misfortune.

Much attention had been given to the diagnosis and, most importantly, the management of spinal injury patients since Guttmann refuted the age-old view that spinal injury patients were, prognostically, a hopeless group. By introducing sound basic nursing and physiotherapeutic principles he managed to assure his patients of a reasonable future.

The aim of this project was to investigate a number of factors related to diving injuries that occur in South Africa, and if possible to draw informative conclusions from these results which might be of benefit to the general public.

Patients and methods
The methods used to obtain the data included a study of patients' clinical notes, the analysis of cervical radiographs, and the posting of a detailed questionnaire to each available patient admitted to the spinal unit of the H. F. Verwoerd Hospital in Pretoria and the Conradie Hospital near Cape Town.

Since most reports on diving injuries concentrate on the medical aspects of the injured patients, we constructed our survey to include an investigation of the patients' viewpoints and experiences. The questionnaire therefore covered areas such as retrospective comments on first-aid treatment, social and occupational adaptation, influence on relationships, and advice to the swimming public. Twenty-three patients with spinal injuries due to diving were treated at the H. F. Verwoerd Hospital Spinal Unit, between 1969 and 1979. These 23 diving injuries accounted for only 4% of the total spinal injury admissions. At the Conradie Hospital, 42 such patients were admitted during the period between January 1964 and January 1980, comprising a mere 1.8% of the total spinal trauma admissions.

Findings
The foremost feature emerging from this review is an area specificity as regards incidence, circumstances of injury and social habits.

In the Pretoria group 42% of the patients studied were injured in a swimming pool with or without water, while 53% sustained spinal trauma by diving into natural waterfall pools, dams, rivers or streams. In the Cape Town area nearly 50% fractured their cervical spine while diving into the sea and the rest were hurt in pools, streams and rivers. The difference in these figures is related to the availability of natural or other swimming facilities.

Alcohol consumption before the diving accident was a contributing factor in nearly 50% (11 out of 23 patients) of the H. F. Verwoerd Hospital admissions, compared with less than 1 in 5 of the Conradie Hospital group.

The average age of the Pretoria patients, 24.4 years (range 17-44 years) is very similar to the 24.0 years (range 13-55 years) of the Conradie Hospital patients.

Only 1 patient of the 23 patients (4.3%) in Pretoria was female. At Conradie Hospital the ratio was similar, i.e. 2 females among the 42 patients admitted (4.8%).

The majority of injuries were high cervical injuries occurring in the region C4-C6. In Pretoria the percentage of spinal injuries in this region was 73.9% and at Conradie 80.5%.

Not much could be learned about the initial first-aid treatment received by the patients. Most patients were grateful to the bystander who happened to be close by and rescued them. Since virtually all rescuers were not medically qualified, one could not expect correct first-aid handling, but it was disturbing to read the retrospective criticism by some patients of the insensitive and often incorrect management by some qualified medical staff attending patients at hospital en route to the spinal units.

We found no correlation between the type of patient under discussion and the level of education or the type of work previously performed by the patient. Interesting enough, the activities of almost all the patients after rehabilitation were similar in quality to their previous occupations.

There was no uniform order of preference as regards restoration of body functions. This is not surprising, since each patient has his own personal needs, likes and dislikes and has adapted individually to his handicaps.

Familial and other relationships were strengthened in a deeper and more meaningful way in the majority of cases. For many this 'forced inactivity' gave time for meditation on the meaning of life. They concluded that life has much more to it than a normally functioning body.

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As regards the advice of the spine-injured patients to the public at large and particularly those who enjoy outdoor life, a unanimous warning emanated from the questionnaires that were returned, advising divers to give a second thought to that daring challenge or that show-off dive, and swimmers to exercise the utmost care while playing in the sea or a pool. It is interesting to note that a fair number of patients blamed themselves for a careless attitude which had directly resulted in their calamity.

Discussion

A large number of articles have been published on diving injuries. In our survey we endeavoured to present the South Africa scenario and found that when our findings were compared with those from other parts of the world\(^1\)–\(^3\) the conclusion is reached that diving injuries do not form a uniform group, since social habits, the availability of natural pools or rivers, the proximity of the sea, swimming, surfing and diving habits, differences in the weather, attitudes towards alcohol consumption, etc. differ in the various countries and regions. On the other hand, we did obtain a picture of the ‘typical patient’ as far as sex, age, social environment, mechanism of injury, injuries sustained, and level of tetraplegia were concerned. This ‘typical patient’ is described in the conclusion.

There is reason to believe that a number of diving injury patients drown before they are rescued, and are therefore not recognized as having diving injuries. In fact, some histories from survivors recall an all-out effort to get their faces out of the water by turning their bodies to face upwards. This might suggest that some victims turn an incomplete lesion into a complete one by this violent turning motion. Those unfortunate people who sustained complete tetraplegia and happened to face downwards must necessarily have ended up drowning.

In the discussion that followed on the Annual Scientific Meeting of the International Medical Society of Paraplegia, held in Mulhouse, France, in July 1979,\(^4\) different views were presented regarding the change in neurological condition of the patient during the initial stages of first-aid management. Weiss (Poland) believes that up to 50% of his patients were not paralysed at the moment when they hit the bottom. Hardy of Great Britain mentioned the role that oedema and haemorrhagic necrosis might play after the trauma, while McSweeney, also from Great Britain, reminded the panel that the patient’s history might be misleading since the support of the limbs by the water might have given the impression to the patient that ‘my limbs were moving’.

Although these injuries are termed diving injuries, it is significant that only a very small number of patients had additional injuries to their hands and arms.

Weiss (Poland) postulated a reflex flexion of diving patients when they hit the bottom of a pool. This would explain to some extent our findings, described above.

Radiographs of the cervical spine show that the mechanism of injury in virtually all cases is an axial compression force with varying degrees of flexion (Fig. 1). In those few diving injury patients with no neurological deficit treated at the H. F. Verwoerd Hospital, a pure axial compression force caused compression fractures only, namely two Cl Jefferson-type fractures\(^4\) (Fig. 2) and one C5 body fracture (Fig. 3).

No exact figures are available for diving injuries without spinal cord injuries, the so-called ‘bumped-head’ or ‘sprained neck’. Since many patients with head injuries do arrive in casualty

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**Fig. 1.** Subluxation in flexion with C5 body compression fracture.

**Fig. 2.** Cl Jefferson-type compression fracture.
departments for radiography to exclude bony lesions, it is of paramount importance to be very cautious of 'minor injuries' or 'NAD' (no abnormality detected) reports. These 'unimportant' injuries may be very serious owing to ligament damage which renders the cervical spine unstable. Scher\textsuperscript{13-16} has published a number of articles highlighting some of the signs that are useful in helping to detect the not-so-obvious lesions, e.g. the acute kyphotic angulation and divergence of the spinal processes, the spinolaminar line, mobility studies and retropharyngeal swelling in the diagnosis of fractures of the atlas.

**Conclusion**

In conclusion, although the quoted series are small (Pretoria 23 patients and Conradie 42), some of the differences noted between the two groups are sufficiently significant to prove the point that diving injuries do not form a uniform group. However, an overall picture of the 'typical patient' involved in diving accidents was obtained: young male (± 24 years), often responding to a challenge at a social gathering where alcohol consumption played an important role; the dive is often not the first attempt and is often into a pool of some sort or at a location that is familiar to the patient; the forehead strikes either the bottom of the pool, a rock, or a sandbank, without any additional injuries, e.g. to the hands; and the radiographs reveal a flexion-axial compression injury to the C4 - C6 region of the cervical spine, leaving the majority of patients in a state of permanent and complete tetraplegia.

From this conclusion I extend the urgent advice to the young, active, 'sporting' male — reconsider that 'daring challenge' issued at a social meeting — it might end in disaster. This advice was given by all the patients who returned their questionnaires.

**Addendum**

Since the conclusion of this project, an additional 10 diving injury cases have been admitted to the H. F. Verwoerd Spinal Unit over a 12-month period. This is an alarming figure and the general public should be made well aware of the dangers of 'social swimming'.

I wish to express my sincerest appreciation to Dr A. Key of the Conradie Hospital for making available the data needed for this study, and to Mrs Griesel of the Spinal Unit, H. F. Verwoerd Hospital, for her help in gathering the necessary information.

**REFERENCES**