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(Part II)**

**FRACTURE DISLOCATION OF THE CERVICAL SPINE: A
CRITIQUE OF CURRENT MANAGEMENT IN THE UNITED STATES**

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Abstract. The author has been asked to review the hospital records and X-rays of 12 patients from various regions of the United States who have sustained fracture dislocations of the cervical spine.

In no instance was the initial care considered to be appropriate.

No patient was significantly improved by treatment although only 17 per cent had apparent complete transverse cord syndromes on admission. Sixty-seven per cent of the patients became worse. In the latter group there were three patients who were admitted with either no neurological deficit or only minimal pyramidal signs. All of these three patients became tetraplegic as a consequence of their not being immobilised or placed in traction during periods of many hours to several days after admission.

There is little evidence that the treating physicians understood the need for immediate immobilisation, proper examination, steroid therapy, adequate safe radiological examination, expedited traction, postural adjustments, or follow-up examination. After-care was poor, leading to excessive complication. Two patients were transferred in deteriorating condition to other hospitals without safeguards and with adverse result.

The availability and the performance of neurological surgeons during the first critical hours after injury was generally suboptimal. Although all of the patients were admitted within an hour of injury only three were seen by a neurosurgeon within 2 hours of admission. Three patients were seen between 36 hours and 8 days. The remaining six patients were examined between 4 and 36 hours and at an average of 12 hours. Skeletal traction was instituted on an average of 11 hours after admission excluding one case of delay for 9 days. Only two patients had adequate reduction within 28 hours. Steroids were given to eight patients at an average of 6½ hours following admission but usually in inadequate dosage.

Five laminectomies and six anterior fusions were eventually performed. Two patients had both operations. One patient subsequently expired. No patient had a surgically remedial lesion or showed postoperative favourable change in cord function. Five operated patients developed spine deformity, persistent dislocation, spinal canal stenosis or instability.

This care was generally attested to meet proper standards and to represent the treatment ordinarily rendered when academic and qualified neurosurgeons gave testimony regarding it. Neither the funding of care and research, nor the adopted codes governing treatment in accredited hospitals, nor accepted teaching would appear to have influenced the substandard of care provided these patients. Other statistics confirm this to be a prevailing circumstance.

Key words: Cervical fracture dislocation; Inadequate care; Traction; Steroids; Laminectomy; Fusion.

Introduction

THERE are high costs which must be assumed each year in the United States because of the medical expenses and the social needs of some 10 000 patients who sustain spinal cord injury. It is an unfortunate fact that such injury typically affects young persons. Most commonly, the victim is the male driver of an automobile which crashes during the early hours of the morning (Ducker & Perot, 1972-74). The expenses of the emergency and acute care are borne by insurance companies, local communities, and, often to the point of both financial insolvency and emotional depletion, the families of such patients. It would seem timely to this observer, in view of the profound disabilities which generally result as well as the escalating nature of the problem, that all perspectives which relate to the quality of medical care being purchased at such considerable expense should be examined. One such perspective is that of the injured patient who complains about his treatment.

Large sums of money must also be provided at the state and private level for the rehabilitation centres to which these patients are usually transferred. The federal government gives major financial support to five spinal cord injury clinical research centres through funding by the National Institute of Neurological and Communicative Diseases and Stroke (NINCDS), a project in progress since 1970. Federal funds support veterans administration hospitals which admit a certain number of these patients and federal tax dollars also provide relief to such patients under our programmes of Social Security. It also seems relevant to ask if these tax dollars which are being so expended would appear to have had any impact upon the adequacy of treatment as it is being delivered under our present system of treatment for the acute stages of this critical illness.

During the last 5 years, the writer has reviewed hospital records and X-rays of such patients in various regions of this country. These materials were sent to me by attorneys seeking an opinion of the adequacy of care. A detailed evaluation of the clinical management of those patients is the subject of this report and answers quite negatively the questions which have been posed.

I believe that what happened to these patients is a reliable indicator of the kind of treatment which most individuals can expect to receive almost anywhere in America should they have the misfortune to be injured by an accident which fractures or dislocates the cervical vertebrae. The pattern of care evidenced by this study is not dissimilar from that reported by the National Spinal Cord Injury Registry (Ducker & Perot, 1972-74). Those who would still suggest that these patients represent exceptions should only need reminding that in every instance board certified neurosurgeons and often professors, as well, of neurological surgery did insist or were prepared to state under oath that the treatment which was received was consistent with their concept of normal, prevailing standards of care. It is also significant that the treating doctors claimed generally that they treated other patients each year in an identical manner, and that the experts who defended that manner came often not only from the same region but over extended distances. The kind of care described in this report is not uncommon therefore, nationwide. That such treatment is not consistent with what responsible neurosurgeons teach and write is best for patients of this type is also a deserving subject of discussion.

The further declaration by neurosurgeons and neurologists, among whom one may identify individuals we give national prominence, that patients with such injuries, however treated, have no significant chance of recovery, is not only at

odds with what we know and write but would also tend to reinforce that defeatism which seriously diminishes our prospects for achieving the much needed improvement in care required by these patients.

Since the initial medical needs of these injured are ordinarily quite simple, would we not also be well advised to consider a transfer of the acute aspects of the care of such patients to well organised medical or paramedical personnel rather than to count upon the doctors in emergency rooms, who change frequently and who seem not to know what to do, or upon American neurosurgeons who, although declared to be in surplus, appear neither to be available nor to believe that they can be helpful to these patients during the first critical hours when they are needed? Rescue teams of this type could then move the patient on to spinal cord injury centres appropriately dispersed and oriented more to clinical needs than to basic experimental research. Such considerations are the inescapable implications of this report.

Clinical data and statistics

The statements of treating physicians, hospital records, and radiographs of 12 patients were studied. These covered the acute phases of the injury. The medical reports, hospital records, and radiographs during subsequent care were also reviewed when available. All expert opinions regarding diagnosis and the propriety of patient care as reflected by reports or sworn testimony were also studied. Individual case reports are included in analytical tabloid format with corresponding comments (Tables I-XII).

TABLE I

Age	22	Cord status (continued):	
Sex	M	complete	
Alcohol	—	incomplete	C5-6 severe incomplete
Geographic section	north east	detection	—
Hospital:		Respirations	1° diaphragmatic after 10 hours
accredited	+	Adequacy neurosurgical exam.	—
type	medium community	Timing neurosurgical exam.	—
Injury:	thrown from motorcycle	Adequacy follow-up exams.	—
hours before admission	1 hour	Undesirable head and neck movements	+
level	C5-6	Skeletal traction:	
mm dislocation	5 mm with compression fracture C5	timing hours post admission	15 hours
Head injury:		effectiveness	—
level of consciousness	alert	duration	6 weeks
Other injury higher priority	—	Effort to reduce dislocation:	
Preliminary immobilisation of neck	sandbags intermittent	expedited	—
Adequacy admission neurological exam.	—	radiographic control	—
Timing of neurological exam.	+	postural adjustment	—
Steroids:	+	adequate weight	— maximum 15 lb
hours after admission	16 hours	Adequacy of turning	— Q2H after 2 days
adequacy	+	Operation	—
Halter traction:		Final status:	
preliminary	+	skeletal	
timing hours after admission	1½ hours	reduction	+
adequacy	—	deformity	—
X-rays:		cord	C5-6 severe incomplete
quality	—	roots	C5-6 incomplete
adequacy	— only to C6	bladder infection	+
detection abnormality	+	decubiti	+
Cord status:		hypotension	+
normal		pulmonary infection	—

This 22-year-old male was admitted with severe incomplete tetraplegia and transferred to a bed in a routine care area where a nurse administered cervical halter traction overnight with 6 lb of weight. Patient examined by neurosurgeon 11 hours after admission. No further X-rays completed until after skeletal traction instituted about 15 hours after admission. That X-ray showed no significant change. A third X-ray 4 days later reported improvement; however, subsequent films indicated persistent dislocation. Traction weight was nevertheless reduced. Neurosurgeon considered transection to be possibly anatomical and life compromising when called at time of admission.

TABLE II

Age	26	Adequacy neurosurgical exam.	+
Sex	M	Timing neurosurgical exam.	-
Alcohol	+	Adequacy follow-up exams.	-
Geographic section	north east	Undesirable head and neck movements	+
Hospital:		Skeletal traction:	
accredited	+	timing hours post admission	8 hours
type	large university affiliated	effectiveness	+
Injury:	thrown from sports car on ice	duration	5 weeks
hours before admission	3/4 hour	Effort to reduce dislocation:	
level	C5-6	expedited	-
mm dislocation	5 mm	radiographic control	-
Head injury:	+	postural adjustment	+
level of consciousness	alert	adequate weight	+
Other injury higher priority	-	Adequacy of turning	-
Preliminary immobilisation of neck	-	Operation	+
Adequacy admission neurological exam.	-	Anterior interbody fusion:	
Timing of neurological exam.	+	indications	-
Steroids:	+	performance	+
hours after admission	9 hours	timing	5 weeks after admission
adequacy	-	neurological result	no change
Halter traction	-	skeletal result	fusion
X-rays:		Final status:	
quality	-	skeletal	
adequacy	- only to C5	reduction	+
detection abnormality	-	deformity	-
Cord status:		cord	C5-6 severe incomplete
normal		roots	C5-6 severe incomplete
complete		bladder infection	-
incomplete	C5-6 incomplete	decubiti	+
detection	+	hypotension	-
Respirations	intercostal weakness	pulmonary infection	+

This 26-year-old male received demerol upon admission producing vomiting and cyanosis. Diagnostic X-rays were not obtained until repeat examination 6 hours after admission. He was turned without cervical immobilisation. Neurosurgical evaluation was conducted 6 hours after admission. Skeletal traction was instituted 2 hours later. Reduction required 13 hours. Anterior interbody fusion at 5 weeks led to atelectasis, pneumonia and tracheostomy. He was turned every 2 hours the first day, thereafter every 4 to 6 hours. He developed severe, extensive, multiple decubiti requiring surgical repair. Decubiti penetrated into both hip joints producing ankylosis and femoral head necrosis.

TABLE III

Age	21	Cord status (continued):	
Sex	F	detection	+
Alcohol	-	Respirations	diaphragmatic
Geographic section	north east	Adequacy neurosurgical exam.	-
Hospital:		Timing neurosurgical exam.	unknown
accredited	+	Adequacy follow-up exams.	+
type	large community university affiliated	Undesirable head and neck movements	+
Injury:	auto collision	Skeletal traction:	
hours before admission	1 hour	timing hours post admission	3 hours
level	C6-7	effectiveness	-
mm dislocation	2 mm with compression fracture C6	duration	3 weeks
Head injury:	+	Effort to reduce dislocation:	
level of consciousness	alert	expedited	-
Other injury higher priority	-	radiographic control	-
Preliminary immobilisation of neck	sandbags	postural adjustment	-
Adequacy admission neurological exam.	-	adequate weight	- maximum 10 lb
Timing of neurological exam.	+	Adequacy of turning	- Q2H
Steroids:	+	Operation	-
hours after admission	1 1/2 hours	Final status:	
adequacy	-	skeletal	
Halter traction	-	reduction	-
X-rays:		deformity	-
quality	+	cord	C6-7 incomplete
adequacy	+	roots	C6-7 incomplete
detection abnormality	+	bladder infection	-
Cord status:		decubiti	-
normal		hypotension	-
complete		pulmonary infection	-
incomplete	C6-7 incomplete		

This 21-year-old female was admitted with C6-7 tetraplegia but generally intact sensation to touch over entire body. Pain and position sense were subsequently identified in both feet and plantar responses noted to be flexor. Skeletal traction was not radiographically monitored for effects until 24 hours following admission at which time persistent dislocation noted. Myelogram performed and showed slight widening cord at C6-7 but no change in degree of dislocation with flexion or extension of neck. Some indication of narrow canal. Transferred at 24 days to a rehabilitation centre.

TABLE IV

Age	61	Undesirable head and neck movements	+
Sex	M	Skeletal traction:	
Alcohol	-	timing hours post admission	9 days
Geographic section	north central	effectiveness	+
Hospital:		duration	2 weeks
accredited	+	Effort to reduce dislocation:	
type	medium community	expedited	-
Injury:	fell 10 feet at work striking head and shoulder	radiographic control	- after 3 days traction
hours before admission	1 hour	postural adjustment	-
level	C5-6	adequate weight	+
mm dislocation	4 mm	Adequacy of turning	-
Head injury:	+	Operation	+
level of consciousness	alert	Laminectomy:	C5-7
Other injury higher priority	-	indications	-
Preliminary immobilisation of neck	collar intermittent	performance	-
Adequacy admission neurological exam.	-	timing	- 12 days after injury
Timing of neurological exam.	+	neurological result	no improvement
Steroids:	-	skeletal result	no improvement
hours after admission	-	Anterior interbody fusion:	
adequacy	-	indications	+
Halter traction	-	performance	-
X-rays:		timing	- 9 days after laminectomy
quality	+	neurological result	no improvement
adequacy	- C7 not well seen	skeletal result	fusion
detection abnormality	-	Final status:	
Cord status:		skeletal	+
normal	-	reduction	-
complete	-	deformity	-
incomplete	C5-6 mild incomplete	cord	C5-6 severe incomplete
detection	-	roots	C5-6 severe incomplete
Respirations	normal	bladder infection	+
Adequacy neurosurgical exam.	+	decubiti	-
Timing neurosurgical exam.	-	hypotension	-
Adequacy follow-up exams.	-	pulmonary infection	+

This 61-year-old male was admitted following a concussion with minimal weakness of the upper limbs and no complaint of lower limb difficulty. Bilateral extensor plantar responses were diagnosed as evidence of diabetic neuropathy. Although X-rays showed C5-6 dislocation, this was diagnosed as arthritis. The patient was ambulated during a period of one week in a cervical collar. He developed progressive severe tetraplegia. He was transferred to a second hospital without proper safeguards by ambulance. At the second hospital, he was turned without stabilisation for 1 day. Skeletal traction was instituted at the second hospital 28 hours after admission. Laminectomy and anterior fusion were not followed by related improvement.

TABLE V

Age	15	Adequacy neurosurgical exam.	-
Sex	M	Timing neurosurgical exam.	+
Alcohol	-	Adequacy follow-up exams	+
Geographic section	south west	Undesirable head and neck movements	+
Hospital:		Skeletal traction:	
accredited	+	timing hours post admission	2 hours
type	medium community	effectiveness	not determined
Injury:	wrestling at school	duration	5 days
hours before admission	1 hour	Effort to reduce dislocation:	
level	C5-6	expedited	-
mm dislocation	1-2 mm with compression fracture C5	radiographic control	- after 2 days traction
Head injury:	-	postural adjustment	-
level of consciousness	alert	adequate weight	-
Other injury higher priority	-	Adequacy of turning	-
Preliminary immobilisation of neck	cervical collar	Operation	+
Adequacy admission neurological exam.	-	Laminectomy:	C5-6 with posterior fusion C4-7
Timing of neurological exam.	+	indications	-
Steroids:	+	performance	-
hours after admission	4 hours	timing	- 2 hours after admission
adequacy	-	neurological result	worse by higher level involvement
Halter traction	-	skeletal result	narrow canal
X-rays:		Final status:	
quality	+	skeletal	+
adequacy	- only to top C6	reduction	-
detection abnormality	+	deformity	narrow canal
Cord status:		cord	C3 complete
normal	-	roots	C3 complete
complete	-	bladder infection	-
incomplete	C5-6 severe incomplete	decubiti	-
detection	-	hypotension	+
Respirations	diaphragmatic	pulmonary infection	after laminectomy
			+

This 15-year-old male with a C5-6 incomplete cord lesion and minimal dislocation was taken to the operating room immediately following admission. With skeletal traction unmonitored for effect and set at only 7 lb, he underwent limited laminectomy with dural opening followed by posterior fusion. Postoperatively, he developed a complete transverse cord syndrome at a higher level with upper limb paralysis as well as total loss of respirations and caudal sensation below C3. Radiographs 2 days following surgery include only C1-4. Traction was reduced to 5 lb. He was transferred to another hospital on the fifth postoperative day where he subsequently expired.

TABLE VI

Age	17	Undesirable head and neck movements	+
Sex	F	Skeletal traction:	
Alcohol	-	timing hours post admission	37 hours
Geographic section	north central	effectiveness	-
Hospital:		duration	2 months
accredited	+	Effort to reduce dislocation:	
type	small community	expedited	-
Injury:	thrown from back seat of motorcycle striking car	radiographic control	- after 14 days
hours before admission	1 hour	postural adjustment	-
level	C4-5 and C5-6	adequate weight	-
mm dislocation	each, 5 mm	adequacy of turning	-
Head injury:	+	Operation	+
level of consciousness	restless	Laminectomy:	C4-6
Other injury higher priority	-	indications	-
Preliminary immobilisation of neck	sandbags intermittent	performance	-
Adequacy admission neurological exam.	-	timing	- 2 days post injury
Timing of neurological exam.	+	neurological result	no improvement
Steroids:	+	skeletal result	-
hours after admission	36 hours	Anterior interbody fusion:	C4-7 with strut graft iliac crest
adequacy	+	indications	-
Halter traction	-	performance	-
X-rays:		timing	9 days post injury
quality	-	neurological result	no improvement
adequacy	- only to C5	skeletal result	-
detection abnormality	-	Final status:	
Cord status:		skeletal	
normal	+	reduction	-
complete	-	deformity	+
incomplete	-	cord	C5-6 severe incomplete
detection	-	roots	C5-6 severe incomplete
Respirations	normal	bladder infection	+
Adequacy neurosurgical exam.	-	decubiti	-
Timing neurosurgical exam.	-	hypotension	+
Adequacy follow-up exams.	-	pulmonary infection	+

This 17-year-old female was admitted with a scalp laceration and was restless initially but had no neurological deficit. She was moved repeatedly for various diagnostic studies including IVP and aortography to evaluate haematuria. Her neck was never stabilised. Radiographs which were incomplete below C5 were interpreted to show only C5 compression fracture not evident dislocation at C4-5. She received no steroids. She was given heparin. She became paraparetic 20 hours following admission. Transferred by ambulance to another hospital over a 3-hour period, she became paraplegic en route and developed upper limb weakness. Skeletal traction was instituted and followed by immediate laminectomy. The cord was normal but the dura was left open. Two fusion procedures (graft slipped) done subsequently added to severe deformity including reversal of curvature and persistent dislocation. X-rays not performed until 2 weeks following second admission. Head was elevated postoperatively. Final result was severe tetraplegia with considerable sensory preservation including lower limbs.

TABLE VII

Age	16	Adequacy neurosurgical exam.	-
Sex	M	Timing neurosurgical exam.	-
Alcohol	-	Adequacy follow-up exams.	-
Geographic section	north central	Undesirable head and neck movements	+
Hospital:		Skeletal traction:	
accredited	+	timing hours post admission	4 hours
type	large community	effectiveness	-
Injury:	tackled playing football	duration	3 weeks
hours before admission	1/2	Effort to reduce dislocation:	
level	C6-7	expedited	-
mm dislocation	> 5 mm	radiographic control	- daily
Head injury:	-	postural adjustment	minimal
level of consciousness	alert	adequate weight	+
Other injury higher priority	-	adequacy of turning	- Q3-4 hours
Preliminary immobilisation of neck	-	Operation	+
Adequacy admission neurological exam.	-	Laminectomy:	C5-T2
Timing of neurological exam.	+	indications	-
Steroids:		performance	-
hours after admission		timing	- 5 days after admission
adequacy		neurological result	no improvement
Halter traction	-	skeletal result	-
X-rays:		Final status:	
quality	+	skeletal	
adequacy	- only to C5	reduction	-
detection abnormality	-	deformity	+
Cord status:		cord	C6-7 complete
normal		roots	C6-7 severe incomplete
complete		bladder infection	-
incomplete	C6-7 incomplete	decubiti	-
detection	-	hypotension	+
Respirations	diaphragmatic following admission	pulmonary infection	-

This 16-year-old boy had inadequate X-rays conducted without safeguards against further cord injury. Diagnosis was made only after repeat X-ray examination at 4 hours. Then seen by neurosurgeon and placed in skeletal traction. Prior to traction, he became hypotensive, developed fully diaphragmatic respiration and lost residual hand grasp as well as extensor type plantar responses. Reduction never accomplished. Tongs slipped out four times and patient fell from Stryker frame. Laminectomy done at 5 days with dentates cut and dura left open. Followed by instability, deformity, and increased upper limb paralysis. Traction was discontinued after 3 weeks. Cord syndrome complete on transfer at 6 weeks.

TABLE VIII

Age	25	Cord status (continued):	
Sex	M	incomplete	
Alcohol	+	detection	+
Geographic section	north east	Respirations	normal
Hospital:		Adequacy neurosurgical exam.	-
accredited	+	Timing neurosurgical exam.	-
type	large community	Adequacy follow-up exams.	-
Injury:	driver car struck tree	Undesirable head and neck movements	+
hours before admission	1 hour	Skeletal traction:	
level	C5-6	timing hours post admission	10 hours
mm dislocation	5 mm	effectiveness	-
Head injury:	+	duration	2 weeks
level of consciousness	disoriented semiconscious	Effort to reduce dislocation:	
Other injury higher priority	-	expedited	-
Preliminary immobilisation of neck	sandbags and collar intermittent	radiographic control	-
Adequacy admission neurological exam.	-	postural adjustment	-
Timing of neurological exam.	+	adequate weight	-
Steroids:	+	Adequacy of turning	- Q8H
hours after admission	8 hours	Operation	-
adequacy	-	Final status:	
Halter traction	-	skeletal	-
X-rays:		reduction	-
quality	-	deformity	+
adequacy	- only to C4	cord	C5-6 severe incomplete
detection abnormality	-	roots	C5-6 severe incomplete
Cord status:		bladder infection	+
normal	+	decubiti	+
complete		hypotension	+
		pulmonary infection	+

This 25-year-old male became tetraplegic 5 hours after admission and developed diaphragmatic respirations. Diagnosis of fracture dislocation was made only after repeat X-ray examination an hour later. Admission X-rays showed only upper four cervical vertebrae in lateral films although malalignment at C5-6 was suspected in AP film. Patient was moved and turned, with twisting of head and neck, even into prone position for admission X-rays of skull, neck, chest, radius, femur and for treatment of fractures of radius and femur. Patient was seen by neurosurgeon after 36 hours who charted no examination until 23 days later. Management for first 2 days, including skeletal traction to cervical spine, by general surgery residents without supervision. No reduction of dislocation ever accomplished and traction discontinued after 2 weeks. Patient slipped from Stryker frame.

TABLE IX

Age	15	Timing Neurosurgical exam.	+
Sex	M	Adequacy follow-up exams.	-
Alcohol	+	Undesirable head and neck movements	+
Geographic section	west	Skeletal traction:	
Hospital:		timing hours post admission	2 hours
accredited	+	effectiveness	-
type	medium community	duration	7 weeks intermittent
Injury:	fell from fence	Effort to reduce dislocation:	
hours before admission	about 1 hour	expedited	-
level	C6-7	radiographic control	-
mm dislocation	2 mm compression fracture C6	postural adjustment	-
Head injury:	+	adequate weight	- 15 lb reduced to 8 in 1 day
level of consciousness	drowsy	Adequacy of turning	- Q2H
Other injury higher priority	-	Operation	+
Preliminary immobilisation of neck	-	Anterior interbody fusion:	C5-7
Adequacy admission neurological exam.	not recorded	indications	-
Timing of neurological exam.		performance	-
Steroids	-	timing	- 16 hours after admission
Halter traction	-	neurological result	no improvement
X-rays:		skeletal result	narrowed canal
quality	+	Final status:	
adequacy	+	skeletal	-
detection abnormality	+	reduction	-
Cord status:		deformity	+
normal		cord	C6-7 complete
complete	C6-7 complete	roots	C6-7 incomplete
incomplete		bladder infection	-
detection	+	decubiti	+
Respirations	normal	hypotension	-
Adequacy neurosurgical exam.	+	pulmonary infection	+

This 15-year-old male sustained brief concussion, compression fracture of C6 and transverse cord syndrome at that level but respirations, bowel sounds and blood pressure normal on admission. He received no steroids. He was given four injections of heparin in doses of 10 mg. Benefit of skeletal traction on 2 mm C6-7 dislocation compromised by anterior operation 16 hours after admission, intermittent 8-12 lb traction, and progressive head elevation. Result was unreduced dislocation and posterior migration of remnant excised body C6 which was not well stabilised to iliac bone graft. Spinal canal narrowed at level of graft.

TABLE X

Age	46	Adequacy neurosurgical exam.	-
Sex	F	Timing neurosurgical exam.	-
Alcohol	-	Adequacy follow-up exams.	-
Geographic section	north east	Undesirable head and neck movements	+
Hospital:		Skeletal traction:	
accredited	+	timing hours post admission	6 hours
type	medium community university affiliated	effectiveness	-
Injury:	driver car in vehicular collision	duration	3 weeks
hours before admission	1 hour	Effort to reduce dislocation:	
level	C6-7	expedited	-
mm dislocation	unknown	radiographic control	-
Head injury:	+	postural adjustment	-
level of consciousness	alert	adequate weight	- 15 lb first 4 days
Other injury higher priority	-	Adequacy of turning	- none for 3 days
Preliminary immobilisation of neck	sandbags	Operation	+
Adequacy admission neurological exam.	-	Anterior interbody fusion:	C5-6
Timing of neurological exam.	+	indications	-
Steroids:	+	performance	-
hours after admission	6 hours	timing	- 3 weeks after admission
adequacy	-	neurological result	no improvement
Halter traction	-	skeletal result	severe deformity C6-7
X-rays:		Final status:	
quality	-	skeletal	
adequacy	- only to C6	reduction	-
detection abnormality	-	deformity	+
Cord status:		cord	C6-7 severe incomplete
normal	-	roots	C6-7 severe incomplete
complete	-	bladder infection	+
incomplete	C6-7 incomplete	decubiti	-
detection	-	hypotension	-
Respirations	normal	pulmonary infection	+

This 46-year-old female was admitted following concussion and scalp laceration with fractured clavicle and incomplete cord lesion consistent only with C6-7 level injury. Sensation retained over trunk and lower limbs. No X-rays obtained of C6-7 level. Skeletal traction was instituted 6 hours after admission. Tongs came out twice during first week. She was not turned for 3 days then Q4H. Patient had C5-6 anterior interbody fusion at 3 weeks after admission for presumed spontaneously reduced dislocation at that level. She was then raised up in bed, mobilised and transferred after a month to a rehabilitation centre. Severe dislocation deformity at C6-7 with 90° angulation not discovered until a year later on admission to a third hospital.

TABLE XI

Age	19	Adequacy neurosurgical exam.	-
Sex	F	Timing neurosurgical exam.	+
Alcohol	-	Adequacy follow-up exams.	-
Geographic section	north central	Undesirable head and neck movements	+
Hospital:		Skeletal traction:	
accredited	+	timing hours post admission	1 hour
type	university	effectiveness	-
Injury:	trampoline struck occiput	duration	9 days
hours before admission	1 hour	Effort to reduce dislocation:	
level	C4-5	expedited	-
mm dislocation	> 5 mm	radiographic control	- after 15 hours
Head injury:	+	postural adjustment	-
level of consciousness	alert	adequate weight	20-35 lb over 15 hours
Other injury higher priority	-	Adequacy of turning	- Q4H
Preliminary immobilisation of neck	-	Operation	+
Adequacy admission neurological exam.	-	Laminectomy:	C4-5, unlocking facets, wiring
Timing of neurological exam.	+	indications	+
Steroids:	+	performance	+
hours after admission	immediate	timing	- 4 days after admission
adequacy	+	neurological result	no improvement
Halter traction	-	skeletal result	reduction
X-rays:		Final status:	
quality	+	skeletal	
adequacy	+	reduction	+
detection abnormality	+	deformity	-
Cord status:		cord	C3 complete
normal	-	roots	C3 complete
complete	C4-5 complete	bladder infection	+
incomplete	-	decubiti	-
detection	+	hypotension	+
Respirations	some intercostal	pulmonary infection	+

This 19-year-old female with severe dislocation at C4-5 was X-rayed without apparent stabilisation. After skeletal traction instituted, she was X-rayed only at 15 hours which showed no reduction with 35 lb. No further adjustments. She had active bowel sounds and rectal sphincter initially. Respirations became diaphragmatic at 24 hours. Tracheostomy and respirator required at 36 hours. Level rose to C3. Operative unlocking of facets delayed until fourth day. Postoperative deterioration with further ascending level to involve brain stem. This improved but patient remained dependent upon respirator with C3 cord level.

TABLE XII

Age	21	Adequacy neurosurgical exam.	-
Sex	M	Timing neurosurgical exam.	+
Alcohol	-	Adequacy follow-up exams.	-
Geographic section	north west	Undesirable head and neck movements	+
Hospital:		Skeletal traction:	
accredited	+	timing hours post admission	2 hours
type	medium community	effectiveness	- only C3-4
Injury:	driver truck, asleep, turned over	duration	8 days
hours before admission	1 hour	Effort to reduce dislocation:	
level	C3-4 and C6-7	expedited	-
mm dislocation	C3-4 (5 mm) C6-7 (unknown)	radiographic control	- at 24 hours and 1 week
Head injury:	+	postural adjustment	-
level of consciousness	alert	adequate weight	-
Other injury higher priority	-	Adequacy of turning	- Q4H p.r.n.
Preliminary immobilisation of neck	sandbags intermittent	Operation	+
Adequacy admission neurological exam.	+	Anterior interbody fusion:	C3-4
Timing of neurological exam.	+	indications	+
Steroids:	+	performance	+
hours after admission	2 hours	timing	- 8 days after admission
adequacy	+	neurological result	no related improvement
Halter traction	-	skeletal result	fusion C3-4
X-rays:		Final status:	
quality	+	skeletal	
adequacy	only to C4	reduction	C3-4
detection abnormality	- only C3-4	deformity	severe dislocation deformity C6-7
Cord status:		cord	C6-7 severe incomplete
normal		roots	C6-7 incomplete
complete		bladder infection	-
incomplete	C6-7 severe incomplete	decubiti	-
detection		hypotension	+
Respirations	diaphragmatic after admission	pulmonary infection	-

This 21-year-old male was never diagnosed by either clinical examination or X-ray to have a C6-7 fracture dislocation. He was admitted with incomplete cord lesion at C6-7 and asymptomatic C3-4 dislocation. The upper level was reduced by skeletal traction and then fused by anterior interbody fusion. The fracture dislocation at C6-7 of 1 cm was determined a month later at another hospital to which he was transferred in Halo brace.

Age. The average age was 25.3 or 19.7 if one excluded the two patients in this series of an older age group.

Sex. Sixty-seven per cent of the patients were males.

Alcohol. Three of the 12 patients were under the influence of alcohol.

Geographic section. Most areas of the country were represented except for the south east.

Hospitals. All patients were treated at accredited hospitals. Save for one large university centre, they were generally treated at good-sized community hospitals, three of which were university affiliated.

Nature of accident. Five injuries involved car or truck crashes. Two accidents were motorcycle related. There were three athletic injuries involving trampolene, football or wrestling. Two injuries resulted from falls of 6 to 10 feet.

Time of injury and relation to admission. All patients were admitted to the hospital within an hour of the time of injury. Half of the admissions were between midnight and 5.30 a.m. Five occurred between 9.00 a.m. and 4.30 p.m. One accident was at 9.10 p.m.

Level of injury. The most common site of dislocation was C5-6 (six cases). Five patients had C6-7 injury. There were two patients with dislocations at two levels.

Head injury. Nine patients were known to have struck their heads. All were alert on admission, however, except for three patients who were described as restless, disoriented or drowsy. These three patients were sufficiently responsive for an adequate motor and sensory evaluation to have been completed.

Other injuries. No patient in this group had significant associated injury that was life threatening or was of higher priority for treatment than that which threatened the spinal cord.

Preliminary immobilisation of neck. There is reliable indication that nine patients were inadequately managed from the standpoint of faulty immobilisation of the neck by sandbags or a cervical collar on admission. In three instances, the record contains either insufficient detail to evaluate the propriety of such application or it is evident that no such immobilisation was used.

Admission neurological examination. Although all patients except one had neurological examinations conducted promptly upon admission to the emergency room, in not a single instance, if the hospital records are to be taken as complete, could one consider that examination to be adequate in terms of providing either a comprehensive baseline for future evaluation or a reliable means for determining accurately either the level and severity of the injury or the clinical needs of the patient. In general, the examiners inscribed in the record fragmented examinations and registered vague diagnoses which commonly were not warranted by the findings they had entered. The latter was particularly true where the diagnosis of cord transection was made in the presence of incontrovertible evidence that continuity existed. Certain physicians insisted subsequently that restlessness or drowsiness precludes a useful examination. Others claimed that pathological reflexes have no useful significance. Several examiners tested for cervical range of motion, a dangerous and unwarranted manoeuvre.

Steroids. Corticosteroids were given to eight patients at intervals varying from 1 to 16 hours after hospital admission and on an average of $6\frac{1}{2}$ hours following admission. In only three of these instances could the dose of steroid be considered adequate and within the therapeutic range ordinarily recommended (Bucy, 1973; White & Yashon, 1973).

Halter traction. Not a single patient was immobilised by halter cervical traction promptly upon admission for the purpose of protecting the cord against further injury, achieving some initial reduction, or rendering radiographic examination more safe. One patient received halter traction of 6 lb, as administered by a nurse, without radiographic monitoring of the consequences, during an 11-hour period in which the neurosurgeon deferred going to the hospital.

Radiographs. There is no indication that any patient was under medical supervision during radiographic studies. There was general insistence that such supervision could be left to the judgement of X-ray technicians. The X-rays of the cervical spine were inadequate in nine patients. Failure to visualise the lowest two vertebrae was the usual reason for considering the films to be inadequate. The films were also of poor quality in five instances. Only five patients were diagnosed properly by initial radiographic examination. Correct diagnosis was achieved later in three patients when radiographs were repeated after intervals of 4, 6 and 7 hours. In four patients, the diagnosis of cervical spine fracture dislocation was not made although the condition existed. Neither patient with two levels of injury was so diagnosed.

Cord status. Two patients were normal on admission. Two had complete transverse cord motor sensory deficits. There were eight patients with incomplete transverse syndromes, one of whom had no weakness of the lower limbs but who manifested extensor plantar responses. A correct assessment of the nature of cord function was only achieved in five instances.

Respirations. One of the normal patients developed diaphragmatic respirations after 8 hours. Both patients with apparently complete transverse cord motor sensory syndromes did have intercostal elements to their respiration on admission. This might raise some question regarding the actual severity of their cord lesions. One of these patients developed diaphragmatic respirations at 24 hours and total respiratory arrest at 36 hours. Of the eight patients with incomplete transverse cord syndrome, four developed diaphragmatic respiration following admission. In one instance, this occurred after laminectomy.

Neurosurgical examination. The hospital records indicate a general inadequacy of the neurosurgeon's examination to the extent that it is reflected by what was written. Only

three examinations could be considered adequate. The timing of neurosurgical examination was also generally suboptimal. Only three patients were examined neurosurgically within 2 hours of admission. Three patients were seen between 36 hours and 8 days following hospital admission. The other six patients were seen between 4 and 36 hours of admission. Follow-up examination was consistently inadequate and infrequently even recorded.

Undesirable head and neck movements. All of these patients, in general, were moved without adequate concern for the stability of the cervical spine during transfers to X-ray, the hospital floors, and the operating room. There was particularly little regard for that requirement during radiographic studies. Radiographs of one patient who was admitted without apparent deficit showed that he was turned prone for skull films and twisted into oblique positions. At later intervals, two patients fell from their Stryker frames. Two of the three patients who entered hospitals with no or minimal deficit early in their clinical course were subsequently transferred in deteriorating condition over long distances by ambulance to other institutions under circumstances which revealed little regard for the hazards of such movement. Sandbags or a collar offered them negligible protection. The result was further deterioration of spinal cord function. The patient who expired was transferred by ambulance to a second hospital only 5 days after his admission and laminectomy even though operation had been followed by complete respiratory and upper limb paralysis. Two other patients were also transferred at 3 weeks to a second hospital for rehabilitative purposes.

Skeletal traction. Table XIII reviews the relevant data. Institution of skeletal traction was usually delayed for an inordinately long period of time although it was finally implemented in every patient. Traction was instituted in two patients only after transfer to other hospitals after 2 and 7 days, respectively. The fracture dislocation was satisfactorily reduced in only two patients during the first 28 hours. Traction was frequently discontinued prematurely.

Effort to reduce dislocation. No patient would appear to have been the subject of a dynamic, expedited, urgently conceived effort to reduce the dislocation in a few hours' time. Follow-up X-rays were usually delayed for an entire day, sometimes for several days.

TABLE XIII
Skeletal traction*

Institution post injury	Effectiveness	Duration
15 hours	—	6 weeks
8 hours	+	5 weeks
3 hours	—	3 weeks
28 hours (on transfer)	+	2 weeks
2 hours	not determined	5 days
37 hours (on transfer)	—	2 months
4 hours	—	3 weeks (out 4 X)
10 hours	—	2 weeks
2 hours	—	7 weeks (intermittent)
6 hours	—	3 weeks (out 2 X 1st week)
9 days	+	2 weeks
2 hours	—	8 days

* Instituted on an average of 11 hours following admission, excluding application at 9 days in one patient.

Only in two instances were postural adjustments made. Adequate weight application was instituted in only three patients in one of whom there was long delay.

Turning. Two patients were not turned for 2 days. Six were ordered to be turned every 2 hours but this was irregularly achieved. Four patients were turned every 4 hours. One patient was turned every 8 hours.

Laminectomy. Five patients underwent cervical laminectomy at 2 hours, 2, 4, 5, and 13 days following admission. No patient derived neural benefit from the surgery. The patient for whom the procedure included an unlocking of facets did obtain that result. The 15-year-old patient operated upon 2 hours following admission developed diaphragmatic respiration, a higher level of cord injury and a loss of caudal sensation present before operation. He subsequently expired. Adverse skeletal results in two patients included persistent dislocation, deformity and instability. Two of these patients were also treated subsequently by anterior fusion. These two patients, normal on admission or showing only extensor toe signs, were left with severe tetraplegia and remain non-ambulatory. No benefit could be ascribed to either operation. Compromise of the potential for recovery would appear to be the probable result of surgery.

Anterior fusion. Six patients underwent this procedure 16 hours, 8, 9, 21, 22 and 35 days following admission. One patient developed a narrow canal from displacement of the posterior fragment of the vertebral body. A second patient was fused at C3-4, the level of a clinically asymptomatic dislocation, the second and cord compressive level of dislocation at C6-7 going untreated. A third patient was fused at C5-6 which was non-involved, the dislocation being at C6-7 and neither suspected nor visualised by X-ray. A fourth patient developed severe deformity and persistent dislocation. Some improvement in root function in one patient can not be attributed to the operation. No patient showed better cord function after operation.

Final results. One patient expired. A second is permanently dependent upon a respirator. None are ambulatory. Only three have finally achieved adequate reduction of the clinically important level of dislocation. Cervical deformity is present in at least seven patients. Half of the patients developed bladder infections. Eight patients developed pulmonary infection. Four developed major decubiti.

No patient showed significant improvement of cord function. Sixty-seven per cent became worse. The two patients who were normal and one with Babinski toe signs became tetraplegic.

Discussion

Central to any consideration of the adequacy of care rendered to patients suffering from fracture dislocation of the cervical spine is the question of prognosis.

Although it is argued often by neurosurgeons and invariably by lawyers that the mechanics of the injury, the degree of dislocation, and the general violence of the trauma attending the inaugural clinical event excludes recovery, there is no body of knowledge which justifies the current vogue of making such pronouncements. Major recovery or preservation of normal function has been reported under the worst of these circumstances (Bailey, 1975; Guttmann, 1973). Moreover, our new breed of kinetically oriented neurosurgeons (Albin, 1974) are misled when they calculate the presumptive number of joules of energy absorbed by the spinal cord during falls in the range of 15 feet and then predict that such events, on the basis of certain figures, usually produce 'irreversible spinal cord transection'. Even if one knew the full details of such descents, and they are never known, one could not predict even the possibility of spine fracture, much less that of spinal cord injury, which in any event under such circumstances could be safely predicted to be improbable. The disturbing element in such bleak forecasts, when given

publicly under oath in a courtroom, is that they contribute to an utterly inappropriate pessimism regarding all patients with spinal cord injury which has come to abide in both the professional and lay communities. That attitude has a further crippling effect not only upon the care which such patients receive but also upon any effort which may be made to improve upon it. Poorly informed doctors and the laity are served even less well when qualified neurosurgeons have the audacity to enter courtrooms and to declare that the issue of treatment or its apparent omission, whatever the deviation from some standard of medical care, is in actuality irrelevant, even when the failure to treat promptly raises the question of ordinary human decency, because certain or all fracture dislocations of the cervical spine produce permanent spinal cord injury. There is nothing in the recognised literature to sustain such prognostications under these circumstances.

Suwanela *et al.* (1962) reported that patients admitted to the hospital with complete motor loss but some sensory preservation below the level of injury have a potential for motor recovery and that it is unrelated to the degree of sensory preservation. Ten of 16 such patients developed some lower limb function which amounted to significant recovery in seven patients. These favourable results were obtained in circumstances where skeletal traction was instituted promptly but it was not specified exactly how early after injury skeletal reduction was accomplished. It should be observed that some of these patients also underwent laminectomy which has been shown to usually deter rather than to implement recovery, to cause deterioration of spinal cord function, and to have no established relationship to recovery when it does occur in operated patients (Comarr, 1959; Morgan *et al.*, 1971). Indications for surgery are rare and principally relate to certain circumstances of compression by bone fragments or disc tissue that account for deterioration in normal or partially injured patients who manifest delayed paralysis, clinical worsening, or ascending levels of cord involvement in spite of skeletal reduction (Guttman, 1973).

Black (1973) stated that if there is some preservation of sensation, 50-60 per cent of such patients have a chance of useful motor recovery and that if there is a flicker of toe movement, often the patient may come to walk unassisted. The largest series of such patients with incomplete motor sensory loss was reported by Guttman (1963). Significant improvement was obtained in 65 per cent of his patients with such clinical syndromes at the Stoke Mandeville Spinal Injuries Centre. There would appear to be little valid argument against the insistence that severe but incomplete cord lesions are capable of improvement and are apt to do so if rendered appropriate care. More importantly, it should be appreciated that prognosis can not be suggested upon admission of the patient to the hospital. Michaelis (1969) insists that no dependable prognosis can be given before 6 weeks in tetraplegia and in less than 3 weeks for paraplegia.

But what can be said about complete motor sensory deficit? Although it is sometimes commented that persistence of this condition for 24 hours after it has developed suddenly makes recovery improbable (Black, 1973; Suwanela *et al.*, 1962), physicians with experience in the treatment of this condition know the exceptions to that dictum (Michaelis, 1969). The retrospective argument which insists that recovery was impossible for a particular patient who received suboptimal treatment or who was neglected, merely because at the end of 1 day he was still completely interrupted, must yield to the obvious criticism of judging the original condition by a result itself the handmaiden of despair and the product of treatment prejudiced by an unwarranted pessimism.

Scarff (1960) reported that among 20 patients with complete transverse

syndromes secondary to fracture dislocation of the cervical spine, there were eight recoveries among the ten patients who did not die of pneumonia. Such major recovery included normal lower extremities. Guttmann (1973) reported 33·2 per cent significant improvement of which he estimates that at least 9 per cent were capable of ambulation. Of course, older statistics such as these are based upon results among patients treated at quite variable and frequently delayed intervals following trauma. Sussman (1976) and Gillingham (1976) refer to the favourable results which can be obtained when complete motor sensory deficit is treated effectively by traction in the first 2 hours following injury. Bucy (1973) points out that Gillingham's treatment programme in Edinburgh has prevented any patient from remaining permanently paralysed and quotes a case report of similar satisfactory treatment in the United States. It is hardly likely that this entire favourable experience at the hands of different neurosurgeons who believe in prompt treatment is limited to patients with spinal cord concussion! This is particularly true since recovery developed over extended periods of a week or more and not hours.

Such treatment was feasible for every one of the patients who are the subject of this report and it is especially tragic that two-thirds of these patients were, in fact, incompletely cord injured. Comment is reserved for later discussion regarding those two patients who were normal, but who were made tetraplegic by improper care.

It is difficult to understand the defeatist attitude which abides in the United States regarding the outlook for recovery from cervical fracture dislocation. It does not derive from anything in the medical literature which deals with circumstances that are encountered clinically. Nor is there anything in the experimental scientific literature which provides a reasonable basis for prejudgement of the results of treating acute clinical conditions. There is a general consensus regarding the questionable validity of a clinical simulation arrived at by dropping weights on an exposed monkey spinal cord, much less that of doing so in other animal species. And the salvage rate in the animal laboratory with various treatments that are feasible by conservative methods within the clinical time frame is not unimpressive (Campbell *et al.*, 1973; Ducker & Hamit, 1969). Furthermore, the knowledge that conduction pathways are involved either primarily by compression from vertebral dislocation or secondarily through ischaemic and chemical influences of central gray origin rather than by transection should be taken as an encouraging omen, not grounds for hopelessness.

Functioning largely out of ignorance and influenced by the disastrous experience of neglectful care, many physicians who presently treat these conditions hardly ever do so well enough to offer such patients their real chances for recovery. One editor asks 'What's wrong with Americans?' as he contrasts our experience with that of Great Britain in treating patients suffering the effects of cervical trauma. The problem with American neurosurgeons is that they accept data like that of the National Spinal Cord Injury Registry non-critically and fail to consider the causes of the results reported. Nor do they sharpen the diagnostic acumen which proper treatment of such patients requires. Among these 12 cases there were some said to have anatomical transection of the spinal cord—even with intercostal respirations, with sensation intact in areas below the level of injury, with Babinski toe signs on hospital admission, and even with lower extremity movements!

Attention should also be drawn to the fact that there are important therapeutic objectives other than ambulation in such patients. Proper care is likely to achieve

improvements in nerve root damage at the level of injury and also to avoid the adverse effects of sphincteric paralysis, loss of vasomotor control and impairment of proprioceptive sensibility. There is no good reason for such patients to be plagued by bladder and urinary tract infections, large decubiti, poor nutrition. Even a patient with lower limbs paralysed, but given some of these other obtainable advantages, can become activated and useful to both himself and society.

Linear cervical traction for traumatic tetraplegia has been the traditional method of administering emergency care down through the ages. Historical evidence goes back to the succusio and the extension bench of Hippocrates. Old methods can also be attributed to Sushruta, van Parma, Paré, Malgaigne and others. Glisson and Sayre in the nineteenth century, Lewin and Maigne in the twentieth century, innovated various slings or halters. Direct skull traction was introduced by Crutchfield in 1933. Modifications of such cranial tongs go by the appropriate names of their inventors and are not as important as the original concept nor of enough advantage over the improved Crutchfield tongs to warrant unbridled preference.

The purpose of traction is to realign the spine in order to relieve compression of the spinal cord. Hardly less important is the associated immobilisation which prevents further spinal cord injury by movements which are the result of the patient's activity or of those who care for him. Although it is now accepted that the acute compression associated with the tetraplegia may inaugurate a progression of microvascular and chemical events, the exact nature and even relative significance of which are currently debated, there is no doubt that continuous compression of the spinal cord is also a disadvantage to the patient. It would seem hardly to need arguing that dislocation and cord compression by no stretch of the imagination can be taken to be an asset to the patient. Even Cloward (1969, 1973), who urges early anterior operation, and who argues against sole reliance upon traction, implements cranial skeletal traction immediately following hospital admission.

In 1965, the Committee on Trauma of the American College of Surgeons formalised this concept when it updated an older 1960 manual concerning the early management of various injuries. The committee (1968, 1972) stipulated at that time and has continued to recommend that patients with suspected fracture dislocation of the spine should be X-rayed in about 15 lb of halter traction, under the direct supervision of a responsible physician and that if the diagnosis of fracture dislocation is confirmed, then skeletal traction should be implemented immediately. Expedited weight increases with radiographic monitoring at least every 2 hours was recommended to achieve demonstrable reduction. In practice, the amount of weight has usually depended upon the size and age of the patient, level of injury, degree of muscle spasm, bone stability and facet lockage. The use of extreme amounts of weight applied too rapidly (Yashon *et al.*, 1975) is grounds for controversy and probably admonition. Guttman warns of the danger of spinal cord injury caused by sudden intervertebral distraction or jerking movements upon the neck. He suggests, however, that gentle postural adjustments or judicious manipulation provide advantages in the achievement of reduction (Guttman, 1973).

The basic method of treatment utilising traction, as outlined by the Committee on Trauma, has been subsequently identified as one of the various policies and procedures constituting the minimum guidance for emergency care in accredited hospitals in the United States (Jt. Commission on Accreditation, 1970). The American College of Surgeons has more recently provided a guideline for patients with head injury requiring that they have adequate X-rays of the cervical spine

because of the serious possibility that such patients may have unsuspected associated cervical spine fractures. All of these requirements often go unheeded, the result being the unfortunate consequences of improper treatment as seen in these 12 patients.

It is the opinion of this writer that patients IV, VI, and VIII should be walking today. Two of these patients were without evidence of spinal cord impairment at the time of hospital admission. The third one had extensor toe responses but moved his lower limbs quite well. In two of these patients a proper diagnosis might easily have been arrived at shortly after admission to the hospital and yet it was not. In the other instance, the radiographs of the cervical spine did not include lateral films of the lower three vertebrae. Progressive tetraplegia was the consequence of failure to immobilise and to apply traction to these patients while they were also subjected to a large number of undesirable movements. The final stress upon two of them was their transfer by ambulance across large distances, without adequate safeguards and the subsequent performance upon them of unnecessary laminectomy. It would seem incredible that arguments have been made asserting that patients such as these were destined by the very nature of their original trauma to develop at a much later time their major paralytic effects.

The series of reports made in the United States by the National Spinal Cord Injury Registry (Ducker & Perot, 1972-74) under the aegis of the U.S. Army Medical Research and Development Command indicates that the unsatisfactory treatment pattern identified by this author is in fact otherwise established. According to the statistics of the Registry, which relate to several thousand such injuries, 38 per cent of the patients with C5-6 level injuries were not seen by a neurosurgeon or appropriate specialist within the first 24 hours. At other levels of injury even fewer patients were treated by the neurosurgeon during this critical period. Among 150 randomly selected patients, only 55 per cent had tong insertions during the 1st week and of those who had tongs applied, only 62 per cent had it done during the first 2 days.

It is hardly surprising that among 23 fatal cases in that series, the insertion of tongs on the day of injury or the following day was carried out even less frequently, that is in 39 per cent of the patients, or that in 30 per cent of the patients who expired, tongs were never inserted. This mortality is also unusual because 52 per cent of the patients had C5-6 or C6-7 vertebral level lesions equally divided between these two lower levels, levels not usually considered to represent the most serious threat to life. Nor can the bad or lethal results be attributed preponderantly to laminectomy or fusion procedures which were carried out in only 21 per cent of these cases. Ascending levels of involvement with death by respiratory and cardiac failure did occur, a consequence not to be unanticipated in unrelieved spinal cord compression.

It is also worth noting that the initial report of the Spinal Cord Injury Registry describes the neurological admission status of 150 randomised patients with vertebral trauma. That distribution of deficits includes only 42.6 per cent complete cord lesions. Partial syndromes comprise 17.6 per cent, Brown Sequard 3.2 per cent, central cord 2.6 per cent, and 11.8 per cent include syndromes primarily involving nerve roots. Some 22.6 per cent of the patients were normal. The subsequent clinical course included no change in 50 per cent of the cases, worsening in 10 per cent, whereas 19.3 per cent of the patients ambulated normally. It would appear that although improvement occurred in about 20 per cent of the patients, there was some attrition in the normal group. These figures are better

than the presently reported series in which 67 per cent of the patients got worse, no one improved, and the patients who were normal became tetraplegic. Both studies include conspicuous evidences of worsening and a failure to improve which is inordinately higher than that which might be anticipated. The two groups are generally comparable in terms of sex, age, mechanism of trauma, level of injury, and the percentage of normal individuals on admission. On the other hand, since a smaller number (17 per cent) of the patients in the present report could be considered to have complete transverse syndromes on admission, there is demonstrated quite dramatically the adverse results which patients face when subjected to treatment of a type seen here and also documented in the report of the Spinal Cord Injury Registry.

The results of operation in this series including those which followed upon either laminectomy or anterior body fusion do not bear out the optimistic attitude which some neurosurgeons have held for these procedures. In no circumstance did they lead to the exposure of a condition (*e.g.*, extruded disc or other compression) which might benefit from surgical management, and in fact postoperative cord changes when they did occur were those of deterioration. Skeletal results even in patients in whom surgery was correctly directed were poor in three instances leading to deformity, instability, narrowed spinal canals, and persistent degrees of dislocation. Although there are neurosurgeons who believe that improvement in technique will eventually make operations much safer, this is not likely to be assured. Moreover, it still remains for the advocates of operation to establish that there is a reasonable basis for operation in any significant number of the patients who are operated upon indiscriminately and not for the reasons previously identified and documented by appropriate studies. Even cooling procedures seem to benefit only those with incomplete lesions and who are therefore likely to benefit to comparable degrees from ordinary conservative measures. The failure of patients who undergo surgery to make the postoperative improvement which might be expected had they been managed conservatively suggests rather that previous insistence that surgery compromises improvement are quite correct (Comarr, 1959; Morgan *et al.*, 1971). It is also essential to suggest that since early anterior interbody fusion as advocated by Cloward (1969) is ordinarily preceded by promptly applied skeletal traction, one is hardly justified in claiming that any improvement which occurs derives from the surgery rather than the traction (Sussman, 1976). It can be anticipated that such claims are not likely to be numerous if the general experience proves to be no better than that of Cloward (1969) who has a 47 per cent mortality when this operation is performed in most cases of complete tetraplegia within 2 hours of injury and within 24 hours in all cases. Only two of his 17 quite young patients of this type managed eventually to walk. That result needs consideration in view of a growing reservation regarding the safety of this procedure in other clinical circumstances wherein it has been associated with tetraplegia, even when preoperative spinal cord function was normal (Kraus & Stauffer, 1975). Moreover, such a result is certainly no better than one which can be obtained by conservative management and carries an early mortality rate which far exceeds even the total mortality which has been reported to range between 15 per cent and 30 per cent over an extended period of many years for such patients (Freed *et al.*, 1966; Nyquist & Bors, 1967). Those mortality statistics yield even lower mortality figures when corrected appropriately for age and level of injury.

The clinical use of steroids in spinal cord injury was recommended in 1969 (Ducker & Hamit, 1969). Editorial advocacy of immediate administration was

expressed by Bucy (1973*a, b*) on two occasions. Of the seven patients included in this study who were hospitalised between those years, four received steroid treatment. There were four patients who were hospitalised later and three of them were so treated, with two patients receiving adequate doses. The drug, when given, was usually used in inadequate amounts. This observation is supported by the findings of the Spinal Cord Injury Registry which showed that only 8 per cent of the randomised group received steroids promptly following injury. There were only 17 per cent receiving steroids by the end of the 1st week following injury. It is obvious that even though neurosurgeons, including senior ones, of prominence insist that prompt treatment including steroids may aid in the reversal of complete or incomplete tetraplegia, that demand has had negligible effect upon the manner in which such treatment is being rendered.

The author also considers that the use of low doses of heparin carries certain risks in patients with acutely traumatised spinal cords. It was administered to patients VI and IX.

It is difficult to be convinced that the generally prevalent practice of moving patients with obvious or suspected cervical fracture dislocation to the operating room in order to attach cranial tongs is advisable. The majority of the patients reported here were so treated, eventually. There is no particular technical advantage to be obtained by that transport which puts the patient at additional jeopardy with respect to cervical immobilisation and also wastes valuable time. It is even more difficult to understand why these patients are transferred to other institutions rather than being placed in skeletal traction and retained at the first hospital to which they are brought. The care which they require is not complex. It needs primarily to be informed and devoted. It is hard to imagine that any medical facility which represents itself to be a hospital is properly entitled to do so if it cannot adequately administer to the needs of such patients. This is not argued as an alternative to the establishment of some 50 or more acute spinal cord injury centres with appropriate helicopter service. There is that need. It simply does not seem reasonable to this writer that patients should be moved about at the present time when the current risks of transfer are much greater than the differences of care which one can expect to encounter between different institutions under our present system.

The clinical reports comprising this study do not include observations made in a review of other spine injuries, but they constitute all of the material received by me in cases of fracture dislocation below C3 in the cervical area. I have examined the records of a child with a C1-2 dislocation and secondary hemiparesis who was taken to the operating room for posterior wiring without utilisation of traction. That patient was manipulated prior to surgery without result and then again intra-operatively. The consequence was tetraplegia. I am familiar with the case of another patient who had a cervical fracture dislocation but no neurological deficit. He was placed in skeletal traction of high distractive force without radiographic monitoring. When he became tetraplegic, the doctor, reached by telephone, suggested only that the traction be reduced. A young woman rendered paraplegic in a fall from a trapeze, who sustained an upper lumbar compression fracture, was dislocated as a result of laminectomy and fusion directed to a lower level. Although she subsequently regained some lower limb movement, reoperation was deferred until several days following the return of paraplegia. A second operation was then carried out above the site of cord compression, and included two biopsies of the spinal cord!

One further anecdotal reference is worth making. On 24 March 1977, a

34-year-old physician studying as a fellow in radiation therapy at this university was on rotation assignment in Tanzania at the University of Dar es Salaam where his car overturned. He was unconscious for a brief period and then transferred to a small hospital recumbent on a rear car seat. Over a period of 32 hours, with makeshift immobilisation, he was moved to a second and a third hospital by station wagon, then finally to the university hospital by air ambulance. A 15 mm fracture dislocation at C6-7 was then reduced over a period of 5 hours during which time high doses of decadron were given. His tetraplegia was complete at the C6-7 level. In a few hours his sensory level was observed to drop. This patient regained sensation in his feet within a week and began to move his right leg at 5 weeks, the left subsequently. He has excellent use of his right hand; the left grasp is improving. He now walks assisted and the course is one of steady improvement. It would be insisted by many neurosurgeons in the United States that on the basis of the severity of the injury, the degree of dislocation, and the delay during a poorly supervised transfer that this was a hopeless case. Some might even have called it an anatomical transection of the spinal cord. Of course, they would have been wrong, as wrong as most neurosurgeons are when they use the term anatomical transection, a condition almost never seen clinically or when they use the term physiological transection, a misnomer as it is generally applied, and a condition which is infrequently encountered.*

When care such as that evidenced by this report goes to issue in the courts, it is often argued that since there is considerable indication including that of the Spinal Cord Injury Registry alluding to the fact that neurosurgeons frequently and deliberately treat patients in the same or a similar manner, and since that kind of treatment draws the support of both professors and other qualified neurosurgeons, that a medical standard is being met. The neurosurgeon who insists that to the contrary, irrespective of how frequently it may be ignored, the standard is set, rather, by the teaching of responsible neurosurgeons, has his work cut out for him if he expects to be otherwise persuasive. Although nothing is accomplished in the courtroom, even if he succeeds, which will turn paralysed limbs into useful appendages, it should be obvious, nevertheless, that every time doctors are exonerated in true instances of practising substandard medicine, the time is postponed when such practice of medicine will no longer be tolerated. For this reason, any responsible doctor who aspires to that objective has a quite proper and a professional responsibility to be persuasive. It is unfortunate that the American Association of Neurological Surgeons has insisted (1975) that certain 'proposed standards for testimony', which were later adopted, are binding upon its members when they act as expert witnesses. Included among the requirements are the obligation to present those opinions which represent a 'broad spectrum of neurosurgical thought and practice' as well as 'significant minority viewpoints'. Experts are also cautioned not to 'adopt a position of advocacy'. The manner as well as the content of their testimony is subject to review. If a neurosurgeon acting as an expert does not respect these requirements, he risks censure, dismissal, and even notification of county, state, and national medical as well as bar associations that he is no longer considered to be 'a valid neurosurgical expert by his peers'. The imposition of such standards reflects a profound naïveté regarding the testimony which can be given in courtrooms, restricted as it is so often by leading questions asked on cross-examination and legal considerations and manoeuvres, as well as being divested of its medical essence or arbitrarily narrowed by the frequent insistence that questions be responded to either as

* Patient now walks unassisted (March 14, 1978).

simple affirmatives or negatives. The requirement to set forth every supposedly 'significant minority point of view' can not conceivably be made either in the interest of justice or sound medical teaching. As a case in point, can a responsible neurosurgeon say in all conscience that to operate upon fracture dislocation of the cervical spine, without specific indications, and during the first 2 hours following injury is worthy of mention before a court when youngsters so operated face a 47 per cent mortality? And yet, there are neurosurgeons who go along with the advocacy of a single individual who treats patients this way. They surely have a significant effect upon our treatment of this condition but it is an adverse one. It would seem to this writer that the responsibility of a neurosurgeon acting as an expert witness is no different than that of any other person who testifies in court, and that it is only to tell the truth as he knows it. Nor should there be any requirement upon him to be dispassionate about it! What does one need to be more moved by than the truth as one sees it? Is it conceivable that a witness is even credible when in circumstances such as those we now relate wherein some injured youth with fracture dislocation of his neck has the good fortune to arrive in an emergency room at a prime time and in a prime condition for treatment and yet he is examined in an inadequate fashion, is poorly immobilised, receives no halter traction, has X-rays performed improperly without safeguards, is not effectively placed in skeletal traction, is moved about incautiously, never receives adequate steroids, receives poor after-care without follow-up examinations, and is later operated upon inappropriately with disastrous consequences to both his spinal cord and vertebrae—and that witness can recount those events and his opinion of them dispassionately? The time to aspire to cool objectivity is in the preliminary analysis of the records. Once an opinion has been reached, if a doctor wishes to speak vigorously and as he should if he would meet his responsibility to others and himself as an obliged member of the community at large, then he should not be constrained upon to join that issue any less energetically in the courtroom than he would join it with his students, or his peers, or when he serves such a patient in his own treatment theatre. Even in the more abstract setting of the laboratory, progress is not anticipated from work done without enthusiasm. Who would be so foolish as to suggest that human beings, doctors among them, are not motivated properly or should not even be drawn primarily by that challenge which pleases them the most to engage? And do we now hold those to be overly zealous who succumb, only out of humanism, to a sense of outrage or sympathy over those who are defeated unnecessarily? For that is the bleak circumstance of these patients.

SUMMARY

The author has reviewed the records and X-rays of 12 patients from various regions of the United States who sustained fracture dislocations of the cervical spine.

In each of these cases the initial care was considered by this writer to be inadequate.

No patient subsequently manifested significant improvement, although only 17 per cent had apparent complete transverse cord syndromes on admission. Sixty-seven per cent of the patients became worse. In the latter group, there were three patients admitted with either no neurological deficit or minimal signs. All three of these patients became tetraplegic as a result of failure to apply traction immediately upon admission.

In general, there is little evidence that the treating physicians recognised the

need for early and immediate immobilisation, proper examination, steroid therapy, adequate safe radiological evaluation, expedited traction, postural adjustment and follow-up examination. After-care was generally poor and led to an excessive incidence of complications.

In addition, the availability and the performance of neurosurgical techniques during the first few hours after injury was suboptimal for the most part, and could not be considered to meet the needs of these patients.

Nine patients underwent some form of operative procedure. There were five laminectomies and six anterior fusions. Two patients had both operations. One patient with laminectomy deteriorated and subsequently expired. No patient manifested an improvement in spinal cord function after either procedure. Among the surviving patients who underwent surgery, five had significant spine deformity including persistent dislocation, stenosis of the canal and instability.

Only two patients had adequate reduction of their clinically damaging fracture dislocation within the first 28 hours.

The author is of the opinion that this study confirms the data available elsewhere indicating a serious and unnecessary absence of a system for the delivery of proper medical care to such patients. Remedies would involve the utilisation of non-complex techniques, known to be reliable, which are relatively inexpensive and can be easily delivered.

Efforts to suppress the vigour with which criticism of the care represented here may be expressed, whatever the forum, are regrettable and misguided. Neurosurgeons in particular have the responsibility to object strongly to this totally unnecessary compromise of the capability of such patients to remain normal when only the spine is injured or to recover from paralysis when it occurs.

Neither the funding of patient care and research, nor the adopted codes governing treatment in accredited hospitals, nor accepted teaching would appear to have influenced the substandard of care provided these patients. Other statistics confirm this to be a prevailing circumstance.

RÉSUMÉ

L'auteur a revu les données et les clichés radiographiques de 12 patients aux Etats-Unis victimes de fracture dislocation de la colonne cervicale. 67 pour cent de ces patients se sont présentés plus ou moins avec des symptômes neurologiques et leur condition clinique s'est détérioré graduellement. 17 pour cent d'entre eux se sont présentés avec le syndrome de la complete transection de la moelle cervicale. Trois patients dans ce dernier groupe se sont présentés presque sans déficience motrice ou sensorielle. Dans ce group tous sont devenus quadriplégique à cause du délai de la mise en traction.

Pas un de ces 12 patients on pu regagner leur fonction physiologique ultérieurement. Selon l'auteur les soins d'urgence reçus par ces malades sont franchement inadéquats.

En général on peut affirmer que le plus souvent le médecin en charge ne semble pas reconnaître d'emblée l'importance d'une immobilisation immédiate, d'un examen neurologique approfondi, d'une thérapeutique aux stéroïdes, de l'application immédiate d'une traction cervicale, de la position du malade au lit et finalement de l'importance des examens neurologiques ultérieurs. Les soins consécutifs donnés à ses malades sont généralement pauvres conduisant à des taux de complications assez élevés. Il faut ajouter aussi que l'emploi de techniques neurologiques pour traiter ces patients étaient complètement inadéquat.

Les opérations faites sont les suivants: cinq laminectomies, six fusions antérieures, et deux malades ont subi la combinaison de ces deux procédures opératoires. Un laminectomie est succombé à la suite de complications opératoires.

Parmi les survivants, cinq sujets ont présentés des déformités marquées de la colonne cervicale caractérisées par une dislocation persistante, une stenose du canal vertébrale et

une instabilité des articulations. On ne peut citer que deux malades à avoir eu une réduction satisfaisante de leur fracture-dislocations dans les premières 28 heures.

L'expérience de cet auteur rencontre celle d'autre clinicien un petit peu partout à travers les états-unis, suggérant une absence sérieuse et même peut-être un certain degré de négligence dans le traitement de cette maladie.

On peut remédier à ces inconvénients en recourant à l'utilisation de techniques simples d'expérience prouvée, au coût très raisonnable et qu'il est certainement possible de délivrer avec aisance.

Il n'y a pas moyens de défendre cette carence de soins, ni de supprimer la critique vigoureuse de ce genre de pratique médicale. Quelque soit le forum utilisé pour contester on ne peut en dire que c'est regrettable et mal inspiré. Il incombe en particulier aux neurochirurgiens d'assumer leur responsabilité qui consiste à offrir leurs objections les plus fortes, grâce auxquelles des dommages irréversibles sont infligés à des patients qu'autrement eussent pu demeurer fonctionnels du point de vue du traitement satisfaisant des traumatismes de l'épine.

Il paraît que le financement des recherches et du maniement clinique, ni les règlements gouvernant les pratiques thérapeutiques dans les hôpitaux reconnus, ni les notions acceptées au niveau pédagogique aient pu avoir une influence bienfaisante sur la qualité inférieure des soins procurés à ces malades. Les statistiques de toute sorte confirment le caractère universel de ces circonstances regrettables.

ZUSAMMENFASSUNG

Die Krankengeschichten und die Röntgenbilder von 12 Patienten von verschiedenen Gegenden der Vereinigten Staaten von America, die Brüche oder Dislokationen der Halswirbelsäule erlitten, wurden überprüft.

In jedem dieser Fälle war in der Meinung des Verfassers die erste Behandlung ungenügend.

Keiner dieser Patienten zeigte im weiteren Verlauf entscheidende Verbesserungen, obgleich nur 17% bei der Aufnahme eine komplette Transsection des Rückenmarkes hatten. In 67% dieser Patienten verschlechterte sich das Befinden. In der letzteren Gruppe hatten bei der Aufnahme 3 Patienten keine oder nur minimale neurologische Befunde.

Im allgemeinen waren sich die behandelnden Ärzte nicht klar bewusst über die Notwendigkeit unmittelbarer Immobilisation, angemessener Untersuchung, Steroidgaben, ausreichender und ungefährlicher Röntgenuntersuchung, schneller Reduktion, Änderung der Lage und Nachuntersuchungen. Nachbehandlung war im allgemeinen schlecht und führte zu einer ungewöhnlich hohen Anzahl von Komplikationen.

Die Verfügbarkeit und die Leistung der neurochirurgischen Technik während der ersten Stunden nach der Verletzung war ebenfalls gewöhnlich suboptimal und nicht angemessen für die Bedürfnisse der Patienten.

Neun Patienten hatten Operationen. Fünf waren Laminektomien und 6 anterior Fusionen. Zwei Patienten hatten beide Operationen. Ein Patient mit Laminektomie verstarb. In keinem Patienten wurde die Funktion des Rückenmarkes durch diese Operationen verbessert. Unter den überlebenden Patienten, die chirurgisch behandelt wurden, hatten 5 Deformitäten der Wirbelsäule, einschliesslich permanenter Dislokation, Einengung des Rückenmarkkanals und Instabilität.

Nur zwei Patienten hatten ausreichende Reduktion ihrer klinisch symptomatischen Bruch-Dislokationen innerhalb der ersten 28 Stunden.

Der Verfasser glaubt, dass diese Studie die bereits anderweitig veröffentlichten Daten unterstützt, die eine schwerwiegende und unnötige Abwesenheit eines Systems zeigen das die erforderliche medizinische Fürsorge in solchen Patienten gewährleistet. Abhilfemassnahmen sollten unkomplizierte Techniken einschliessen, die zuverlässig und relativ billig sind und leicht angewandt werden können.

Versuche die Kritik, die hier bezüglich der medizinischen Versorgung dieser Patienten gemacht wird, zu unterdrücken, sind bedauerlich und fehlgeleitet. Neurochirurgen haben eine besondere Verantwortung, unangebrachte Behandlungsformen aufzudecken.

Weder besondere Mittel für Behandlung und Forschung, noch Leitlinien für die Behandlung in akkreditierten Krankenhäusern, noch als angemessen erachtete medizinische Lehre hat anscheinend die unzureichende Behandlung dieser Patienten beeinflusst. Andere Statistiken bestätigen, dass dies im allgemeinen der Fall ist.

REFERENCES

- ALBIN, M. S. (1974). Personal communication, July 1.
- AMERICAN ASSOCIATION OF NEUROLOGICAL SURGEONS (1975). Proposed standards for testimony. *Newsletter A.A.N.S.*, November.
- BAILEY, I. C. (1975). Fracture dislocation of the cervical spine with gross displacement. *J. Neurosurg.* **42**, 209-211.
- BLACK, P. (1973). Injuries of the vertebral column and spinal cord: mechanisms and management in the acute phase. In *The Management of Trauma*, ed. W. F. Ballinger, R. B. Rutherford and G. D. Zuidema. W. B. Saunders Company, Philadelphia, pp. 193-218.
- BUCY, P. C. (1973). Editorial: Emergency treatment of spinal cord injury. *Surgical Neurology*, **1**, 216.
- BUCY, P. C. (1973). Editorial: What's wrong with Americans? *Surgical Neurology*, **1**, 354.
- CAMPBELL, J. B., DE CRESCITO, V., TOMASULA, J. J., *et al.*, (1973). Experimental treatment of spinal cord contusion in the cat. *Surgical Neurology*, **1**, 102-106.
- CLOWARD, R. (1969). Surgical treatment of dislocations and compression fractures of the cervical spine by the anterior approach. *Proc. 17th V.A. Spinal Cord Injury Conference, New York*, pp. 26-35.
- CLOWARD, R. (1973). Skull traction for cervical spine injury: should it be abandoned? Letter to the editor, *J. Amer. Med. Assoc.* **226**, 1008.
- COMARR, A. E. (1959). Laminectomy in patients with injuries of the spinal cord. *Journal of the International College of Surgeons*, **31**, 437-442.
- COMMITTEE ON TRAUMA OF THE AMERICAN COLLEGE OF SURGEONS (1965). *Early Care of Acute Soft Tissue Injuries*. W. B. Saunders Company, Philadelphia and London.
- COMMITTEE ON TRAUMA OF THE AMERICAN COLLEGE OF SURGEONS (1968). *The Management of Fractures and Soft Tissue Injuries*. W. B. Saunders Company, Philadelphia and London.
- COMMITTEE ON TRAUMA OF AMERICAN COLLEGE OF SURGEONS (1972). *Early Care of the Injured Patient*. W. B. Saunders Company, Philadelphia, London, Toronto.
- DUCKER, T. B. & HAMIT, H. F. (1969). Experimental treatments of acute spinal cord injury. *J. Neurosurg.* **30**, 693-697.
- DUCKER, T. B. & PEROT, P. L. (1972-74). National Spinal Cord Injury Registry: Initial report and newsletters II-V. Medical University of South Carolina, Charleston.
- FREED, M. M., BAKST, H. J. & BARRIE, D. L. (1966). Life expectancy, survival rates, and causes of death in civilian patients with spinal cord trauma. *Arch. of Physical Med. and Rehab.* **47**, 457-463.
- GILLINGHAM, J. (1976). Early management of spinal cord trauma. *Neurosurgical Forum J. Neurosurg.* **44**, 766-767.
- GUTTMANN, L. (1963). Initial treatment of traumatic paraplegia and tetraplegia. In *Proc. Symp. Spinal Injuries*, ed. P. Harris. Roy. Coll. Surg., Edinburgh.
- GUTTMANN, L. (1973). *Spinal Cord Injuries: Comprehensive Management and Research*. Blackwell Scientific Publications, Oxford.
- JOINT COMMISSION ON ACCREDITATION (1970). Emergency services. Accreditation manual for hospitals: standard IV. (December), 4.
- KRAUS, D. R. & STAUFFER, E. S. (1975). Spinal cord injury as a complication of elective anterior cervical fusion. *Clin. Orth. and Rel. Res.* **112**, 130-141.
- MICHAELIS, L. S. (1969). Neurological terminology, prognosis and classification of para- and tetraplegia. *Proc. 17th V.A. Spinal Cord Injury Conference, New York*, pp. 215-217.
- MORGAN, T. H., WHARTON, G. W. & AUSTIN, G. N. (1971). The results of laminectomy in patients with incomplete spinal cord injuries. *Paraplegia*, **9**, 14-23.
- NYQUIST, R. H. & BORS, E. (1967). Mortality and survival in traumatic myelopathy during nineteen years, from 1946 to 1965. *Paraplegia*, **5**, 22-48.
- SCARFF, T. (1960). Injuries of the vertebral column and spinal cord. In *Injuries of the Brain and Spinal Cord and their Coverings*, ed. S. Brock. Williams and Wilkins, Baltimore, p. 565.
- SUSSMAN, B. J. (1976). Early management of spinal cord trauma. *Neurosurgical Forum J. Neurosurg.* **44**, 766.
- SUWANELA, C., ALEXANDER, E. & DAVIS, C. H. (1962). Prognosis in spinal cord injury

with special reference to patients with motor paralysis and sensory preservation. *J. Neurosurg.* **19**, 220-227.

WHITE, R. J. & YASHON, D. C. (1973). General care of cervical spine injuries. In *Neurological Surgery*, ed. J. R. Youmans. W. B. Saunders Company, Philadelphia, pp. 1049-1066.

YASHON, D., TYSON, G. & VISE, W. M. (1975). Rapid closed reduction of cervical fracture dislocations. *Surgical Neurology*, **4**, 513-514.