

## ■ EDITORIAL

# Care following acute traumatic spinal cord injury

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In the study by Graham et al<sup>1</sup> in this issue of *The Bone & Joint Journal*, the authors state that their aim was to compare two distinct systems for the care of patients with spinal cord injury: that developed by the National Spinal Injuries Centre, Stoke Mandeville, UK (the Stoke Mandeville system; SMS), which is primarily conservative, and that practised by USA centres, which is more surgically orientated and contributes data to the Spinal Cord Injury Model Systems (SCIMS) database.

They compared the neurological outcomes of 608 patients treated at Stoke Mandeville Hospital (SMH) between 1951 and 1968 and 300 patients treated using the same system at Colmar Mulhouse and Basel (CMB) between 1968 and 1978,<sup>2,3</sup> with 804 patients admitted to SCIMS rehabilitation centres in the USA between 2011 and 2018.<sup>4</sup>

The difference in outcomes was striking. Neurological deterioration occurred in 12 SMS patients (1.3%) (2% of SMH cases, 0% of CMB cases) and 13.2% in SCIMS cases. The authors also argued that the SCIMS outcomes should have been better because there were more cervical spinal cord injuries in the USA series (which they argue – and we might debate it – may be expected to have a better outcome). They calculated that if the SCIMS patients had been treated conservatively, neurological deterioration would not have occurred in between 71 and 87 of them; between 195 and 330 more might have walked, and between 129 and 264 more might have been completely cured, compared with only nine patients (1.1%) who achieved a complete recovery.

The periods of time during which the three studies reporting outcomes – 1951 to 1968,<sup>2</sup> 1968 to 1978,<sup>3</sup> and 2011 to 2018 – varied considerably.<sup>4</sup> They analyzed retrospective data covering a period of nearly 75 years. The two SMS datasets were not aggregated because of changes in medical techniques with the passage of time, and the differences in time taken between injury and admission to the spinal cord injury units.

The SCIMS data were initially reported as American Spinal Injury Association (ASIA) grades,<sup>5</sup> which were converted to Frankel grades<sup>2</sup> to allow comparison with the SMS data.<sup>4</sup> The 804 SCIMS patients had significantly different demographics and injury-related variables from those

who were excluded from the analyses (3,544; 76.5% of those on the database).

Factors which may have influenced the outcomes of the studies included: the choice of inclusion and exclusion criteria; the case mix; the 1990 change in the USA definition of Frankel grade A;<sup>6</sup> the date on which outcome data were recorded; problems with distinction between Frankel grades C and D; changes in medical technology (better use of catheters, new antibiotics, better beds, surgery, and better rehabilitation); and the impact of neurological deterioration. In general, these should all have favoured the SCIMS system.

The authors estimated that 643 SCIMS patients (80%) were treated surgically. This cannot be confirmed as Kirshblum et al<sup>4</sup> did not provide these data. The National Spinal Cord Injury Statistical Center (NSCISC) database shows that the documented rate of surgical intervention in these patients was less than 50%.<sup>7</sup> In the 2021 report,<sup>7</sup> the dataset between 1973 and 2021 shows surgical intervention in 14,346 patients (40.2%), no surgery in 4,621 (12.95%), and unknown surgical intervention status in 16,708 (46.8%). From these figures, it would seem that about 40% of patients had surgery, rather than the 80% estimated by the authors. However, if the same proportion of the unknown cases in the Kirshblum et al<sup>4</sup> dataset had surgery (75.6% of the known NSCISC cases had surgery), another 245 patients (78% of 324 unknown cases) would have had surgery. If this is correct, the proportion of those who underwent surgery (620 of 804) was 77.1%.

The study has the advantages of a large number of patients, and using the same grading system for each group (albeit retrospectively for the SCIMS group). Its additional strength lies in the authors' attempt to compare outcomes across vastly different periods of time and healthcare systems. Although there are intrinsic problems with the data, we agree that the authors have done the best that they could with the available data.

The SMS system is based on meticulous non-surgical stabilization of the spinal column and attention to the physiology of every system, with the aim of preventing the complications which might arise from the neurological deficit. This includes bed rest for between six and eight weeks

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until recovery of autonomic and spinal reflexes, and a multisystem approach to the management of the physiological aspects of spinal cord instability. This approach treats lost physiological function conservatively with non-surgical interventions, such as catheterization of the bladder to prevent hydronephrosis and renal failure, and good bladder and bowel control to mitigate autonomic dysreflexia. Prevention of the consequences of spinal instability includes the management of spinal shock and the maintenance of vital capacity and assisted cough. Once physiological stability is achieved, rehabilitation begins during the time of recumbency and is continued after mobilization. It is acknowledged that, historically, there were limited techniques for surgical stabilization of the spine, and only between 10% and 15% of SMS cases underwent surgery. The SMS approach was not withholding surgery, but was based on a belief that between six and eight weeks was initially required for the management of spinal cord instability, and that during this time the spinal column healed sufficiently to allow mobilization in a brace.

As spinal surgical techniques evolved, more centres recommended surgery to stabilize the spine and moved away from the principles of SMS. The SCIMS approach focuses on early surgery to stabilize the spine and in some cases to decompress the spinal cord (a separate issue which we will not further address here). Surgery is intended to reduce the risks of displacement of the fracture(s), reduce the care demands on nursing staff, and allow earlier rehabilitation. This has become the dominant protocol for the care for patients with traumatic spinal cord injury throughout the world.<sup>8</sup>

A patient with a spinal column and/or cord injury can deteriorate neurologically. Secondary neurological deterioration can either involve an increased severity of cord injury at the same spinal level (e.g. C6 ASIA D becoming C6 ASIA C) or an injury at a higher level (e.g. C7 to C5), or both. The most common cause of secondary neurological deterioration after a spinal cord injury is failure to immobilize the cervical spine when there is an unstable fracture and/or dislocation. Excessive movement at this level is potentially preventable. In patients with a spinal cord injury without an unstable injury of the spinal column, or in whom instability has been surgically stabilized, neurological deterioration occurs because of physiological instability. This form of instability, including hypotension, hypovolaemia, and/or hypoxia, is common in patients with a spinal cord injury.<sup>9</sup> Any patient with a cervical spinal cord injury can develop orthostatic hypotension and/or hypovolaemia due to autonomic failure, which can cause impaired blood flow to a damaged spinal cord which, in turn, causes more severe injury to the cord.

Orthostatic hypotension, which is of particular concern, is a decrease in systolic blood pressure (BP) of  $\geq 20$  mm Hg, or  $\geq 10$  mm Hg of diastolic BP, on moving from a supine position for  $> 3$  mins.<sup>10</sup> It has been reported in the past to occur in 74% of patients with a spinal cord injury,<sup>11,12</sup> and is more likely with higher levels of injury or those at or above T6 and with complete cord lesions. It is more common in acute cord injury and tends to improve with the passage of time. It can cause dizziness, syncope, and cognitive dysfunction,<sup>13</sup> and it may be asymptomatic. Blood flow to the injured cord is dependent on BP and volume, both of which fall with orthostatic hypotension.<sup>14</sup> Ischaemia of the spinal cord, potentially causing further

neurological damage is another risk.<sup>14</sup> The incidence of secondary neurological deterioration in patients with a spinal cord injury who have orthostatic hypotension is not known, but may occur in up to 20% of these patients. In a study which included 263 patients who had tilt-table studies six weeks after an acute incomplete spinal cord injury, treated with bed rest,<sup>15</sup> the study was stopped in 71 patients (27%) because of hypotension and in 20 (7.6%) because of neurological deterioration. Sympathetic function improves after a spinal cord injury and eventually results in a reversal of orthostatic hypotension. However, the frequency of orthostatic hypotension at six weeks after a spinal cord injury would suggest even higher levels in the early hours or days after injury, when the lack of sympathetic drive is at its maximum. This seems to be a reasonable assumption, but it cannot be tested because it would be unethical to perform such a study in these patients.

A cervical spinal cord injury can also cause hypoxia because of respiratory failure, particularly if the patient is elevated (a change of position from 'head down' to 'head up').<sup>16,17</sup>

Some authors have advocated the use of vasopressors in patients with an acute spinal cord injury to treat hypotension, suggesting that this might improve neurological recovery. Typically, a target BP would be a mean arterial BP of between 85 and 90 mm Hg. This has not been shown to improve outcomes.<sup>18</sup> Whether or not there is an optimum target BP for these patients, it is essential to avoid hypotension, hypovolaemia, and hypoxia.

In conclusion, the two systems of management for an acute spinal cord injury (SMS and SCIMS) have not previously been compared. This study offers a fascinating insight into the development of a medical speciality over a 75-year timespan, and calls into question the underlying evolution of the patterns of care for patients who have sustained this injury. There is a need for better data transparency, which is required for evidence-based medicine, in this area. The authors have been very diplomatic in their conclusions. It is not unreasonable to conclude that at least part of the reason for moving towards a more surgically based system was financial, as surgical stabilization is much cheaper than six to eight weeks of conservative treatment. What the authors suggest is that in concentrating on surgical stabilization and rapid mobilization, the treatment of spinal instability has become the focus of treatment of patients with a spinal cord injury, and the management of the spinal cord has been lost. The increased rate of neurological deterioration in the SCIMS cases is explicable on the basis of unrecognized and/or untreated spinal cord instability. This is supported by the 0% rate of neurological deterioration in the modern SMS study (CMB),<sup>3</sup> compared with 13.2% in the SCIMS cases,<sup>4</sup> and the current SCIMS management seems to be inferior to SMS management. Surgical stabilization of the spinal column clearly aids all aspects of the physical management of these patients, and this surgery is usually now of low morbidity. However, in our opinion, and based on the current data, the SMS approach should be adopted after surgical stabilisation to identify (and/or prevent) and treat the consequences of spinal cord instability. Whether this is possible in the current economic climate is uncertain.

## References

1. **Graham JM, Graham BT, El Masri WS.** Traumatic spinal cord & cauda equina injuries: a comparison of neurological outcomes achieved by a 75 year-old system of management and modern care in the USA. *Bone Joint J.* 2026;108-B(3):425–430.
2. **Frankel HL, Hancock DO, Hyslop G, et al.** The value of postural reduction in the initial management of closed injuries of the spine with paraplegia and tetraplegia. I. *Paraplegia.* 1969;7(3):179–192.
3. **Philippi R, Kuhn W, Zäch GA, Jacob-Chia D, Dollfus P, Molé JP.** Survey of the neurological evolution of 300 spinal cord injuries seen within 24 hours after injury. *Paraplegia.* 1980;18(5):337–346.
4. **Kirshblum S, Botticello A, Benedetto J, et al.** A comparison of diagnostic stability of the ASIA impairment scale versus frankel classification systems for traumatic spinal cord injury. *Arch Phys Med Rehabil.* 2020;101(9):1556–1562.
5. **Maynard FM, Bracken MB, Creasey G, et al.** International Standards for Neurological and Functional Classification of Spinal Cord Injury. American Spinal Injury Association. *Spinal Cord.* 1997;35(5):266–274.
6. **American Spinal Injury Association.** *Standard for Neurological Classification of Spinal Injured Patients.* 3rd edition. Chicago, Illinois, USA, 1990.
7. **Chen Y.** National Spinal Cord Injury Model Systems Database. National Spinal Cord Injury Statistical Centre. 2021. <https://bpb-us-w2.wpmucdn.com/sites.uab.edu/dist/f/392/files/2024/06/ar2021.pdf> (date last accessed 21 January 2026).
8. **Wilson JR, Witiw CD, Badhiwala J, Kwon BK, Fehlings MG, Harrop JS.** Early surgery for traumatic spinal cord injury: where are we now? *Global Spine J.* 2020;10(1 Suppl):84S–91S.
9. **El Masry WS.** Physiological instability of the spinal cord following injury. *Paraplegia.* 1993;31(5):273–275.
10. **The Consensus Committee of the American Autonomic Society and the American Academy of Neurology.** Consensus statement on the definition of orthostatic hypotension, pure autonomic failure, and multiple system atrophy. *Neurology.* 1996;46(5):1470.
11. **Claydon VE, Steeves JD, Krassioukov A.** Orthostatic hypotension following spinal cord injury: understanding clinical pathophysiology. *Spinal Cord.* 2006;44(6):341–351.
12. **Sachdeva R, Nightingale TE, Krassioukov AV.** The blood pressure pendulum following spinal cord injury: implications for vascular cognitive impairment. *Int J Mol Sci.* 2019;20(10):2464.
13. **Nightingale TE, Zheng MMZ, Sachdeva R, Phillips AA, Krassioukov AV.** Diverse cognitive impairment after spinal cord injury is associated with orthostatic hypotension symptom burden. *Physiol Behav.* 2020;213:112742.
14. **Ruiz IA, Squair JW, Phillips AA, et al.** Incidence and natural progression of neurogenic shock after traumatic spinal cord injury. *J Neurotrauma.* 2018;35(3):461–466.
15. **Kumar N, Osman A, Chowdhury JR.** Traumatic spinal cord injuries. *J Clin Orthop Trauma.* 2017;8(2):116–124.
16. **Cameron GS, Scott JW, Jousse AT, Botterell EH.** Diaphragmatic respiration in the quadriplegic patient and the effect of position on his vital capacity. *Ann Surg.* 1955;141(4):451–456.
17. **Cirignigliaro CM, Lesser M, Moyer J, Kirshblum SC, Bauman WA, Spungen AM.** Reproducibility and effect of posture on impulse oscillation parameters in persons with spinal cord injury. *J Spinal Cord Med.* 2012;35(1):28–34.
18. **Afshari FT, Choi D, Russo A.** Controversies regarding mobilisation and rehabilitation following acute spinal cord injury. *Br J Neurosurg.* 2020;34(2):123–126.

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