

# Cauda equina syndrome: a review of the current clinical and medico-legal position

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**Abstract** Cauda equina syndrome (CES) is a rare condition with a disproportionately high medico-legal profile. It occurs most frequently following a large central lumbar disc herniation, prolapse or sequestration. Review of the literature indicates that around 50–70% of patients have urinary retention (CES-R) on presentation with 30–50% having an incomplete syndrome (CES-I). The latter group, especially if the history is less than a few days, usually requires emergency MRI to confirm the diagnosis followed by prompt decompression by a suitably experienced surgeon. Every effort should be made to avoid CES-I with its more favourable prognosis becoming CES-R while under medical supervision either before or after admission to hospital. The degree of urgency of early surgery in CES-R is still not in clear focus but it cannot be doubted that earliest decompression removes the mechanical and perhaps chemical factors which are the causes of progressive neurological damage. A full explanation and consent procedure prior to surgery is essential in order to reduce the likelihood of misunderstanding and litigation in the event of a persistent neurological deficit.

**Keywords** Cauda equina syndrome · Central disc prolapse · Bilateral sciatica · Urinary retention · Perineal hypoaesthesia · Sexual dysfunction

## Definition

Cauda equina syndrome (CES) is usually characterised by these so-called ‘red flag’ symptoms:

- Severe low back pain (LBP)
- Sciatica: often bilateral but sometimes absent, especially at L5/S1 with an inferior sequestration
- Saddle and/or genital sensory disturbance
- Bladder, bowel and sexual dysfunction

It is most important, both from a clinical and from a medico-legal perspective, that any or all of these ‘red flag’ symptoms are specifically identified, documented and acted upon appropriately.

## Background

CES is a rare condition with a disproportionately high medico-legal profile. It occurs most frequently following a large lower lumbar disc herniation, prolapse or sequestration. CES may also be caused by smaller prolapses in the presence of spinal stenosis [25].

Less common causes are epidural haematoma [22], infections [6], primary and metastatic neoplasms [3], trauma [17, 20, 45], post surgical [21], prolapse after manipulation [40], after chemonucleolysis [41], after spinal anaesthesia [34] and it has been reported in patients with ankylosing spondylitis [38], gunshot wounds [13] and even resulting from constipation [27].

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This review will address the problem of CES resulting from compression by lumbar disc herniation, prolapse or sequestration about which most has been written.

Tandon and Sankaran [44] described three variations of CES (T and S groups):

1. Rapid onset without a previous history of back problems.
2. Acute bladder dysfunction with a history of low back pain and sciatica.
3. Chronic backache and sciatica with gradually progressing CES often with canal stenosis.

It is evident that the onset of CES may be either acute within hours or gradual over weeks or months, and within these groups CES may be complete with painless incontinence or incomplete with some sphincter function.

Although the above description is clinically useful, in medico-legal and also clinical terms the important distinction is whether, at any given time, CES is complete or incomplete in relation to urinary function and perineal sensation [16]. A useful test, not generally described, is the test for trigone sensitivity in which an inflated Foley catheter is gently pulled with the patient unaware [47]. This should produce the urge to micturate. This will help to distinguish patients with a genuine neurological deficit from those who have purely pain-related retention which is not uncommon [43] as is retention as a result of constipation [27].

When the syndrome is incomplete (CES-Incomplete), the patient has urinary difficulties of neurogenic origin including altered urinary sensation, loss of desire to void, poor urinary stream and the need to strain in order to micturate [16]. Saddle and genital sensory deficit is often unilateral or partial and trigone sensation should be present.

The complete syndrome is characterised by painless urinary retention and overflow incontinence (CES-Retention), when the bladder is no longer under executive control [16]. There is usually extensive or complete saddle and genital sensory deficit with deficient trigone sensation.

It is well established that the outcome for patients with CES-I at the time of surgery is generally favourable, whereas those who have deteriorated to CES-R when the compression is relieved have a poorer prognosis, although around 70% of CES-R patients have a socially acceptable long term outcome [16].

LBP and sciatica are of course common, but bilateral severe sciatica should always ring alarm bells. Its occurrence with any of the so-called 'red flag' symptoms must trigger immediate action generally involving emergency referral to an Accident and Emergency Department with ready access to a Spinal Surgery Unit, preferably accompanied by an explanatory telephone call to reduce delays.

Prompt MR scanning will help to identify the likely cause of a CES [7].

Cauda equina syndrome is a relatively rare condition, comprising around 2–6% of lumbar disc operations [16, 17, 31], with an incidence in the population thought to be between 1 in 33,000 to 1 in 100,000 [1]. In Slovenia, a retrospective review found an incidence of CES resulting from a lumbar disc prolapse of 1.8 per million population [35]. It may be that most UK general practitioners are unlikely to see one true case of CES caused by intervertebral disc herniation in their entire career [26].

General opinion suggests that a proven CES requires prompt and appropriate surgical treatment [16, 19, 25, 32]. The fact that it is a rare condition has made it difficult, in practice, to carry out definitive investigations for high quality prospective studies with statistical power sufficient to draw firm conclusions concerning the principal contentious issues. These are:

- The significance of delays in diagnosis and referral to hospital.
- The risks and benefits of emergency versus urgent surgery.
- The significance of surgical delay beyond 24 and 48 h.
- The prognostic significance of complete versus incomplete sphincter involvement and complete versus incomplete sensory deficit.
- The prognostic significance of unilateral and bilateral leg signs.
- The adverse effects of delay on the more robust sciatic nerve roots.
- The medico-legal implications of the above.

These issues will be discussed along with their clinical context and the range of opinions from the medical literature. Conclusions will be drawn where possible but advisedly, since complex human interactions are involved in the management of this sometimes ill-defined and variable condition and dogmatic statements are unwise.

The analysis of all the variables in CES may be simplified in view of the fact that the most regrettable and damaging consequence of cauda equina compression is bladder dysfunction. The terms CES-I and CES-R as described above denote useful and usually identifiable reference points with some relevance to the timing of surgery and clinical outcome. Clinical studies of CES are of much greater value if these two categories and their outcomes are described separately [10].

As mentioned above CES may develop relatively acutely, usually with severe low back pain and complete anal and bladder motor and sensory loss and usually but not always, with motor and sensory deficits in the lower limbs, all within 24 h (CES-R, Tandon and Sankaran Group 1). Such cases are likely to require prompt treatment [16, 19,

25, 32, 43, 44]. At the other end of the spectrum, low back pain may be mild with gradually developing or intermittent sciatica over weeks or months in one or both legs with incomplete or intermittent deficits of bowel and bladder function (CES-I, T and S Group 3); there may be a relatively modest central disc prolapse causing compression because of a degree of stenosis of the spinal canal. These cases often do not require urgent treatment but careful monitoring is required so that progression to CES-R should always be avoided while under medical supervision [16].

The questions arise as to what extent these variations in time and severity of compression are of prognostic significance. First, for the delicate unmyelinated preganglionic fibres of the cauda equina in or near the midline along with the sacral nerves, and secondly, for the more robust sciatic nerve roots laterally at the exit foramina in which the sensory nerves are of smaller diameter and more sensitive to compression than the motor nerves [37]. The answer is inevitably unclear, with conflicting conclusions in the literature, and especially in individual cases when vital reference data may be missing from the record. One can only advise that the longer compression continues, the more likely is long term neurological damage initially to the autonomic, and subsequently to the somatic components of the cauda equina.

A further factor may be at work apart from mechanical and time factors, and that is the possibility of chemical interference with the function of nerves in contact with the irritating components in prolapsed nuclear material as suggested by Rydevik et al. 1984 [37], Garfin et al. 1991 [14], Olmarker et al. 1993 [33] and DeLong et al. 2008 [10]. Involved nerve roots are sometimes noted to be grossly swollen and inflamed at surgery. It may be that observed nerve recovery, sometimes after 3 days or more have passed before surgical decompression, may at least be partly explained by resolution of this chemical effect. In other situations such as the use or miss-use of a tourniquet, the effect of nerve compression for more than four to six hours is usually considered to be irreversible. On the other hand it may be that the clinical diagnosis of CES-R with its less good prognosis, often on the basis of scanty information, may be overly pessimistic in some cases when they are in fact still CES-I at the time of surgery. The trigone sensitivity test described above may help to define the situation.

The traditional view articulated by Shephard [40] was that “early operation is an essential prerequisite for an improved prognosis”. This seems logical and intuitive if somewhat simplistic, as a discriminating look at the available evidence provides inconsistent support for this point of view. It begs the questions: how early is early? Is it 6, 12, 24 or 48 h or some other arbitrary number, and from which point does the clock start ticking? Is it from the onset

of CES symptoms or from the loss of bladder control or from the time of admission to hospital or surgical unit? Also, what symptomatic characteristics if any are good indicators of prognosis? Is it the presence or absence of perineal sensory loss or unilateral or bilateral sciatica or motor weakness in the lower limbs, or the presence or absence of bladder and/or anal motor or sensory function?

Finally, from a medico-legal angle, at what stage, if at all, was the situation retrievable by surgical decompression? If there was demonstrable delay what difference did this make and what would have been the outcome if that delay had not occurred? The lawyers do ask difficult questions and as involved clinicians or expert witnesses we have not only to admit our uncertainty where necessary, but also we must be careful not to stray from the validated behaviour patterns of this complex and variable condition.

## The literature

In order to try to clarify matters, the relevant literature has been reviewed and the essential points are described below. It seems reasonable to start with the largest CES study in terms of case numbers; subsequent papers are reviewed in chronological order of publication.

The extensive meta-analysis by Ahn et al. from Johns Hopkins University, Baltimore [2] involving 322 patients from 42 publications seemed to be an authoritative guide through this complex maze. It indicated that: “there was a significant advantage to treating patients within 48 versus more than 48 h after the onset of CES. A significant improvement in sensory and motor deficits as well as urinary and rectal function occurred in patients who underwent decompression within 48 versus after 48 h.” They also stated that: “no significant improvement in surgical outcome was identified with interventions less than 24 h from the onset of CES compared with patients treated within 24–48 h”.

However Kohles et al. [24] from Portland, Oregon critically reassessed the Ahn paper and concluded that although an advantage existed in treating patients within 48 h, there was further benefit in treating patients within 24 h, concluding rather bluntly: “that a flawed methodology and misinterpretation of results are reported, understating the value of early surgery”.

Kohles et al. while appreciating the work involved in the Ahn et al. paper and the conclusion that the results of surgery have some time sensitivity, make the logical point that the earlier the surgery, including within 24 h, the better the outcome based on a critical reinterpretation of the figures in the Ahn et al. paper.

Gleave and Macfarlane [15] from Cambridge, in a retrospective review of 33 selected cases, all with CES-R at

presentation, recorded that the mean duration of bladder paralysis was 3.6 days and 79% of their patients claimed full recovery of bladder function but only 22% were left without some perineal or limb sensory deficit. Retention developing less than 48 h after an acute prolapse was associated with a poorer prognosis.

Gleave and Macfarlane believe that in the majority of cases “the die is cast at the time of the prolapse”, depending on the rapidity of its development and the severity of the nerve compression. They state that in this group of CES-R patients, “there is no evidence to support the view that emergency surgery influences the degree of recovery”. Other more recent researchers have agreed with this finding [19, 29, 36] while others have warned against undue delay for the logical reason that a damaging process is best halted as soon as is reasonably possible [10, 12, 43].

Emergency surgery in the middle of the night by inexperienced staff may not be in the patient’s best interest. Crocker et al. [8, 9, 46], have addressed this issue along with that of the lack of out-of-hours MRI facilities in a large number of non-regional centres in UK which accept emergency admissions. In fact they found that of 82 patients referred with suspected CES and undergoing emergency MRI, the diagnosis was confirmed in 27 (33%), but only 5 patients required emergency surgery, 15 were on the next available daytime operation list and 6 had their surgery after more than 24 h. Clearly emergency MRI and surgery were probably of great importance for those five individuals who might otherwise have suffered disabling long term neurological compromise, but evidently these costly facilities were not essential for the other 77 patients. Where does one draw the line? It is evident that just one individual avoidably disabled is a personal tragedy, and in purely financial terms will be a very substantial cost to the community over a lifetime.

The prognosis for an individual with established complete CES-R with no bladder sensation or control is probably not time dependent to the same extent as CES-I, but surgery should be carried out as soon as possible for patient morale and comfort and because any delay in treatment can only worsen neurological recovery with the possibility of continuing damage to the more robust and laterally placed sciatic nerve roots which may have survived the original midline prolapse relatively undamaged [12, 39].

In an authoritative review of the literature in 2002 [16], Gleave and Macfarlane [15] confirmed their previous views and made these important points:

- Those series which include CES-I patients tend to show a favourable outcome from early surgery. However around 70% of their CES-R patients had a good result from surgery carried out a mean of 3.7 days after onset; a similar figure to Shapiro’s group who were operated

upon within 48 h [39]. They agree that CES-I is best treated by early surgery.

- Urodynamic studies can show a serious disturbance of bladder function after cauda equina compression and yet the patient may have no symptoms at all [18].
- Unlike other types of neural injury, recovery of bladder and sexual function may continue for a number of years after an insult [5, 11]. This is unlikely to be due to neural regeneration, but probably reflects the patient’s ability to develop compensatory strategies for coping with bladder sphincter denervation. Length of follow-up is therefore an important variable.
- Recovery of sexual function appears to mirror sphincter outcome, particularly in women, where incontinence during sexual intercourse is emotionally distressing and adds to the problems caused by lack of perineal sensation.
- Gleave and Macfarlane agree with Shapiro [39] that surgical exposure should generally be via full laminectomy rather than microdiscectomy. Permanent damage can result from excessive manipulation of the dura and occasionally transthecal excision may be necessary.
- The point is made that in experimental work in primates and in other clinical situations, nerve ischaemia for more than around 6 h is irreversible. “That window of opportunity is manifestly impossible to achieve in the clinical situation, it must be concluded that the outcome of CES-R has already been decided by the time the patient is admitted to hospital [16]”.

The authors conclude the whilst urgent surgery remains indicated for patients with an incomplete lesion (CES-I) to prevent them from progressing to complete cauda equina syndrome (CES-R), examination of the literature does not support a role for emergency surgery to treat a condition which is complete at the time of presentation to hospital. However MRI and surgery should be arranged as soon as is reasonably possible.

Gleave and Macfarlane are critical of the paper of O’Laoire et al. [32] who advocate surgery with a similar urgency to that required for a subdural haematoma despite finding no correlation between time to decompression and outcome in a series of 29 cases. They point out that such advice may, in the event of incomplete recovery and where treatment is perceived to be less than expeditious, suggest to some that management has been negligent. Critical analysis of the literature, they suggest, is far from convincing in support of such a management strategy [16].

The Gleave and Macfarlane review is authoritative and has formed the basis for many court decisions [30]. However one might comment that another factor in advising early surgery in CES-R patients is the possibility of ongoing damage caused by unnecessary delay to the more

robust sciatic nerve roots confined in the foramina, particularly the sensory fibres which recover less well than the larger diameter motor nerves, these may be more sensitive to compression by an enlarging disc prolapse.

### Summary of management of CES

1. CES is a rare condition but may have devastating consequences for patients, their families and their clinical contacts if the condition is not adequately managed in order to avoid unpleasant clinical and legal sequelae.
2. Early diagnosis by GP or hospital doctor gives the patient the best chance of a satisfactory outcome although 50–70% of patients have a relatively acute onset and “the die is cast at the time of prolapse” [15] or shortly afterwards. However around 50–70% of these unfortunate patients can have an acceptable result with relatively minor deficits following urgent but not necessarily emergency surgery [16].
3. In the other 30–50% of patients with a more gradual onset, prompt and intelligent management by all concerned is vital. The patient must seek help quickly, the GP must then check for urinary dysfunction, perineal numbness, loss of anal tone and examine for neural deficit in the lower limbs. Rapid transfer to hospital must be ensured, preferably with an accompanying telephone call to avoid delays.
4. Accident and Emergency Departments must respond quickly, preferably according to a CES protocol such as that at the end of this paper, by confirming the clinical diagnosis then alerting the spinal surgery team. Baseline neurological criteria should be noted including anal sphincter tone and perineal pin-prick sensation [43]. Ultrasound may be useful in assessing urinary retention [48], and the volume drained on catheterisation should be recorded along with a note of trigone sensitivity [47]. An emergency MR scan should be arranged as soon as possible.
5. A proper explanation and consent procedure concerning short and long term prognosis should take place in order to avoid misunderstanding and the possibility of litigation if a neurological deficit persists [28]. This is followed by decompressive surgery as soon as adequately skilled personnel and infrastructure are available for this often technically demanding procedure. It is a tragedy and usually preventable that CES-I is allowed to progress to CES-R while under medical supervision. However if that progression has already taken place then it seems reasonable and in the patient’s best interest to undergo surgery not as an emergency but under optimal conditions on the next

available operating list, preferably within 24 h of arrival at the hospital. A meta-analysis reported in 2005 demonstrated that patients undergoing surgery earlier than 24 h after the onset of CES are more likely to recover bladder function than those treated beyond 24 h ( $p = 0.03$ ) [43].

6. Sympathetic and supportive multidisciplinary postoperative management over many months may be necessary with the help of a spinal injuries unit, a urologist and/or gynaecologist, a specialist gastroenterologist and social services.

### Prognosis

This is difficult to assess in the individual case with this complex condition as the series described above have varying diagnostic criteria and fixed points in their descriptions, however it is possible to suggest some broad generalisations based on the available information:

- Around half of CES cases present with CES-R at the time of admission to hospital [11, 23, 29].
- There is much evidence that patients with CES-I at the time of surgery have a better prognosis than those with CES-R [10, 14–16, 36].
- Approximately 75% of all CES cases will eventually have acceptable urological function [15], though frequently with chronic back pain and some motor and sensory deficits in the perineum and lower limbs.
- Approximately 20% of all CES patients will have a poor outcome usually with the need for ongoing treatment e.g. management of sexual dysfunction, self catheterisation, colostomy, urological and gynaecological surgery, spinal injuries rehabilitation and psychosocial support.

### Medico-legal considerations

As discussed above there is a balance of evidence in favour of decompressive surgery within 48 h of the onset of CES with some series showing additional benefit if that window is reduced to 24 h. However it is also evident that patients who receive the most expeditious treatment may be left with disabling sphincter and lower limb deficits causing a degree of disability and dependency which quite naturally motivates them, their relatives and their lawyer to try unsuccessfully to prove negligence and obtain redress. In contrast to this fruitless, expensive and psychologically stressful activity, probably the patient’s best option would have been to follow specialist advice, accept the status quo,

so far as is possible, and then try to mitigate their difficulties by seeking the best medical rehabilitation and social support available.

It is also true that some patients are lucky and in spite of being designated CES-R on admission to hospital then subjected to some delays prior to surgery, they eventually have an acceptable long term outcome.

On the other hand the rarity and variability of CES can result in misdiagnosis and delays by first, the patient who may have developed painless urinary retention over the previous 6–8 h and may not have raised the alarm or sought medical advice until the situation was irreversible (if it was ever reversible). Secondly, the GP or therapist may not have appreciated the gravity of the situation and consequently failed to advise immediate transfer to hospital. Thirdly, delays may occur in the hospital [39] with junior doctors and nurses not recognising the syndrome presented to them. Finally, the non-availability of out-of-hours MRI and specialist spinal surgical facilities may singly or collectively cause further delay [8] which may be critical to the eventual outcome, especially if there is evidence of progressing neurological deficit during this time. If any of those imperfections are found to be negligent then substantial damages may be awarded. In our experience damages are more likely if the medical records are deficient with a lack of crucial clinical detail including recordings, with times, of neurological deficits and any changes in bladder function.

The leading professional indemnity societies providing malpractice cover in UK and some Commonwealth countries are The Medical Protection Society (MPS) and The Medical Defence Union (MDU) which cover general practice and private consultant hospital and out-patient practice. National Health Service (NHS) hospital and out-patient cover is provided by the NHS Litigation Authority (NHSLA). As mentioned above CES, although rare, figures large in terms of medico-legal costs:

During the 5 years between January 1st 2003 and December 31st 2007, the MPS was notified of 63 likely claims worldwide relating to CES, of which 46 were in UK. Of the 20 concluded cases, damages were paid to 55% with an average payment of £117,331 per case. This represents a total payout of £1,290,641 over the 5 years (£258,128 per annum), with only one-third of the cases concluded. The highest settlement was £584,000. 43 of the 63 cases related to general practice and 11 to orthopaedic surgery, with two each to radiology and neurosurgery and the remaining five to other specialties [4]. (£1 = 1.10 Euro–March 2010).

In 2004 it was reported that the MDU identified 62 CES related claims of which 42 were concluded and damages were paid in 20 cases (48%) compared with 34% of all

other UK claims, with an average settlement of £336,000 per claim at 2003 prices.

This adds up to a total of £6,720,000 for CES alone. The highest settlement was £759,000, with one of the outstanding claims reserved at £1.1 million. Just under half the 62 cases notified related to general practice involving incorrect or delayed diagnosis, the rest were almost all orthopaedic concerning inadequate treatment or post-operative complications [28].

During the 5 years between 1st April 2003 and 31st March 2008, The NHS Litigation Authority, dealing with NHS hospital problems, was notified of 78 CES related claims. Of the 24 concluded cases, damages were paid in 12 with an average payout of £211,758 per case and a total payout over the 5 years of £2,541,098 (£508,219 per annum), again with only one-third of cases concluded. The highest settlement was £2,041,000. Of the 78 notified claims, 39 related primarily to the Orthopaedic department and 21 to Accident and Emergency with 7 to Neurology or neurosurgery. The remaining 11 related to other departments [42].

## Conclusion

It is evident that CES occupies a prominent position in the medico-legal field partly through lack of awareness and urgency in its management by all concerned, and partly because of the devastating consequences of the condition which even with the best treatment may lead to bowel, bladder, sexual and lower limb dysfunction. It is now established that in around half of cases, the die is cast within the first 4–6 h of a severe central disc prolapse resulting in CES-R. This is invariably an impossibly short length of time in which to achieve referral to an appropriate hospital, confirmation of diagnosis by MRI scan and surgical decompression.

It follows that delay until the next operating list is probably not significantly related to causation in these cases. However, all things being equal, clinicians should aim, if at all possible, to relieve neurological compression within around 48 h of onset bearing in mind that results are probably improved by relief within 24 h or sooner especially if they have CES-I with signs of progression. Early surgery may reduce chronic sciatica [39].

Prompt diagnosis and investigation followed by timely and skilful surgery and rehabilitation are the essentials of best practice in the treatment of this rare but often very damaging condition. It is a tragedy, sometimes avoidable, if an incomplete syndrome becomes complete while under medical supervision.

Litigation is common when a patient has persistent residual symptoms [26], especially if the clinical record is defective and the likely outcome has not been fully explained and understood by the patient prior to surgical intervention.

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Red flag symptoms of cauda equina syndrome (CES): typically from a central PID

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Usually severe LBP and bilateral neurogenic sciatica	
Perineal/genital numbness	
Inability to pass water since >6–8 h	
Triage	
CES: Incomplete—Emergency management!	CES-Retention: Urgent management!
Ideally surgery within 24 h of onset—good prognosis	Ideally surgery within 24 h of diagnosis: less good prognosis
Symptoms	
Sciatica may be unilateral, bilateral or absent (L5/S1 prolapse)—if present, is it increasing in intensity or becoming bilateral?	Sciatica: as for CES-I—NB Lumbar and sacral nerve roots may suffer progressive damage resulting in long term neuropathic leg pain/numbness
Perineal numbness: may be unilateral and patchy, becoming bilateral and spreading	Perineal numbness: as for CES-I but likely to be widespread and complete with diminishing discomfort
Neurogenic urinary dysfunction: HNPU >6 h loss of desire to void, poor stream, strain to micturate, sensation of full bladder	Neurogenic urinary dysfunction: HNPU >8 h painless urinary retention, overflow incontinence, no bladder sensation or control, faecal incontinence
Physical signs	
Sciatica: check for neurological deficit in legs—SLR, reflexes, power and sensation. May be deteriorating and becoming bilateral	Sciatica: as for CES-I. May be more severe and bilateral with increased neurological deficit. May be absent or mild with sequestered L5/S1 prolapse
Perineal numbness: usually incomplete—check light touch and pin-prick—always test for both	Perineal numbness: complete sensory deficit. Check light touch and pin-prick
Neurogenic bladder and bowel dysfunction: check anal sphincter tone (Deletion) and ‘wink’ reflex. Test trigone sensation—pull catheter gently	Neurogenic bladder and bowel dysfunction: painless full bladder, no anal sphincter function. No trigone sensation on pulling catheter

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#### Action!

Immediately seek senior advice with a view to contacting a Spinal Surgery Team and arranging emergency MRI with transfer to a Spinal Surgery Unit if not available on site. Delay may cause further neurological damage!

By Alan Gardner, Edward Gardner, Tim Morley 2010

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