



A review of the readmissions of patients with tetraplegia to the Regional Spinal Injuries Centre, Southport, United Kingdom, between January 1994 and December 1995

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Patients with chronic tetraplegia are prone to develop unique clinical problems which require readmission to specialised centres where the health professionals are trained specifically to diagnose, and treat the diseases afflicting this group of patients. An appraisal of the readmission pattern of tetraplegic patients will provide the necessary data for planning allocation of beds for treatment of chronic tetraplegic patients. Hospital records of patients with tetraplegia readmitted to the Regional Spinal Injuries Centre, Southport, UK between 1 January 1994 and 31 December 1995 were analyzed to find out the number of tetraplegic patients who required readmission, reasons for readmission, duration of hospital stay, and mortality among patients readmitted.

During the 2-year period, 155 tetraplegic patients were readmitted and 44 of them (28.4%) required more than one readmission (total readmission episodes: 221); these patients occupied 4.5 beds which is equivalent to 11.5% of the total bed capacity of the spinal unit. Among the reasons for the readmissions, evaluation and care of urinary tract disorders topped the list with 96 readmission episodes (43.43%) involving 70 patients; the median hospital stay was 3 days, and 18 patients (26%) required more than one readmission during this period. One hospital bed was occupied by the tetraplegic patients requiring treatment/evaluation of urinary tract disorders. Assessment and treatment of cardio-respiratory diseases was the second most common reason for readmission with 51 readmission episodes pertaining to 27 patients having a median hospital stay of 6 days; 13 patients (48%) were readmitted more than once within this 2-year period. Treatment of cardio-respiratory diseases in chronic tetraplegic patients required 1.2 hospital beds yearly. Only five tetraplegic patients were readmitted for treatment of pressure sore(s); however they had a prolonged hospital stay (median duration: 101 days). Social reasons accounted for 13 readmission episodes concerning nine patients who stayed in the hospital for varying periods (median: 6.5 days; mean: 35 days).

Four tetraplegic patients readmitted with acute chest infection expired. An 81 year-old tetraplegic died of myocardial infarction. Urinary sepsis, renal insufficiency, respiratory failure and intra-cerebral haemorrhage accounted for the demise of a 41 year-old tetraplegic patient following surgical removal of a large, impacted stone at the pelviureteric junction. A tetraplegic patient who was admitted with haematuria subsequently underwent cystectomy for squamous cell carcinoma of the urinary bladder; he developed secondaries and expired 5 months later.

As more patients with high cervical spinal cord injury survive the initial period of trauma, and as the life expectancy of tetraplegic patients increases, it is likely that greater numbers of tetraplegic patients will be requiring readmission to spinal injuries centre. Although it may be possible to prevent some of the complications of spinal cord injury and hence the need for a readmission, progress in medicine and rehabilitation technology will create additional demands for readmissions of chronic tetraplegic patients in order to implement the newer therapeutic strategies. Thus a change in the pattern of readmission of chronic tetraplegic patients is likely to be the future trend and this should be taken into account while making plans for providing the optimum care to chronic tetraplegic patients.

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Introduction

Patients with tetraplegia represent a distinct category of patients requiring specialised nursing and medical care. Many of them will require rehospitalisation after discharge from initial rehabilitation. An American study showed that as many as 39% of acute spinal cord injury patients were readmitted at least once during the first year after discharge from initial rehabilitative care.¹ When tetraplegic patients require readmission irrespective of whether the illness is a complication of the spinal cord injury or unrelated to it, they should preferably go to specialised centres where the health professionals are trained specifically to diagnose, and treat the diseases afflicting this group of patients with special needs. Further, chronic tetraplegic patients will be acquainted with the spinal unit, and the health professionals working in the spinal unit will be familiar with the special needs of an individual patient. For example, extracorporeal shock wave lithotripsy (ESWL) of stone(s) in the kidney or upper ureter is an established clinical procedure. However, in a spinal cord injury patient, autonomic dysreflexia with resulting acute rise in blood pressure may occur during lithotripsy. Such an occurrence of a dysreflexic episode during ESWL requires prompt diagnosis and immediate treatment with sublingual nifedipine. Similarly, in a spinal cord injury patient who has developed a post-traumatic syrinx, an acute and severe deterioration of spinal cord function may occur due to the reverberation generated by extracorporeal shock waves used for the lithotripsy, of the fluid within the thoracic post-traumatic syrinx with consequent further damage to the nervous tissue.² Chronic tetraplegic patients may suffer from electrolyte disturbances, a common clinical entity being hyponatraemia. Hyponatraemia may be asymptomatic, or a chronic tetraplegic patient may present with restlessness, confusion and sometimes convulsions. Awareness of the protean manifestations of hyponatraemia, and familiarity with the philosophy of management ie treatment of precipitating factor eg acute urinary or chest infection, fluid restriction, frusemide, cautious use of hypertonic saline, and ventilatory assistance if need be, will result in a favourable outcome.³ Chronic tetraplegic patients who have been taking large doses of senna over a long period may suffer from hypokalaemia. A female tetraplegic patient who was taking 20–25 ml of senna every other night for the past 4 years was admitted for explanation of defunct pump and implantation of a new pump for intrathecal delivery of baclofen for intractable spasticity. During pre-anaesthetic check-up, we considered a possibility of senna-induced hypokalaemia. Our suspicions were confirmed when her serum potassium was detected to be 2.8 mmol/L, and hypokalaemia required correction by oral potassium supplements prior to anaesthesia and surgery.

Further, patients with cervical spinal cord injury are likely to develop unique clinical problems. A 31 year-old female patient with tetraplegia and a presumptive

diagnosis of Guillain Barre syndrome exhibited a sudden rise in systolic blood pressure from 100 mmHg to 200 mmHg while undergoing electrohydraulic lithotripsy of bladder stones under inhalational anaesthesia. This episode of hypertension is due to the occurrence of autonomic dysreflexia triggered by cystoscopy and bladder distension. Timely diagnosis of the dysreflexic episode and prompt treatment by increasing the concentration of isoflurane from 0.65% to 1.4% in order to decrease the systemic vascular resistance, averted any mishap due to autonomic dysreflexia. This case also illustrates the point that tetraplegic patients should be treated by medical and nursing professionals acquainted with the diverse symptomatology and occurrence of illnesses in spinal cord injury patients.

In addition to the unique clinical problems exhibited by chronic tetraplegic patients, the symptoms and clinical signs of a common illness may be quite different in a tetraplegic patient in contrast to a patient with intact neuraxis. A 12 year-old girl with traumatic tetraplegia presented with increased spasms. Investigations revealed a ureteric stone causing hydronephrosis. The symptoms of increased spasticity were relieved after percutaneous nephrostomy drainage in this girl. This clinical episode symbolizes the reality that tetraplegic patients tend to exhibit atypical symptoms and signs of illnesses which may be unrelated to spinal cord injury. Moreover, this case is an example that sudden occurrence of increased spasticity in a tetraplegic patient who was in a stable clinical condition earlier, always demands meticulous investigations for an underlying illness. Lack of familiarity with the unconventional patterns of presentation may lead to a delay or errors in diagnosis and management, which could prove costly both to the patient and to the hospital authorities. An appraisal of the readmission pattern of tetraplegic patients will help to allocate adequate budget for future treatment, so that the care of these patients who survived the initial period of physical and mental agony of paralysis of all the four limbs, chest and visceral function, is not compromised due to lack of beds, facilities, or manpower.

The objectives of this study were to find out (1) the number of tetraplegic patients who required readmission between 1 January 1994 and 31 December 1995 in the Regional Spinal Injuries Centre, Southport; (2) the proportion of patients who required more than one readmission during this period; (3) the reasons for readmission; (4) the procedures performed during the readmission; (5) mortality during the readmission episodes and (6) the duration of stay in the hospital when these patients were readmitted for different conditions.

Materials and methods

The Regional Spinal Injuries Centre, Southport is a supra-regional centre situated in the north-west of

England. During 1994–95, this centre received patients with spinal cord injury from the regions of Merseyside, North-West of England, South Cumbria, and North Wales. The catchment area for this spinal unit has a population of about 6.5 millions. This Centre provides global care to adult and paediatric patients with traumatic tetraplegia and paraplegia who reside in the above geographical regions of England, from the time a person sustains injury to the spinal cord until the demise of the patient. Thus, this spinal unit renders comprehensive treatment to traumatic tetraplegic and paraplegic patients both during the acute and chronic phase. The Centre has the expertise of a multi-professional team and facilities exist for providing treatment in different aspects of spinal cord injury medicine eg surgical fixation of broken spine immediately after trauma to the spinal column, temporary and long-term ventilatory support, implantation of unilateral or bilateral phrenic pacer for supra-nuclear diaphragmatic paralysis, clinical, and uro-pathological investigations and treatment of neuropathic bladder dysfunction, medical and surgical treatment of spasticity including implantation of a programmable pump for intrathecal delivery of baclofen, investigations and treatment of sexual dysfunction and infertility, rehabilitation technology inclusive of upright mobility, upper limb reconstructive surgery in selected tetraplegic subjects, etc.

When a tetraplegic patient registered with the Regional Spinal Injuries Centre, Southport, falls ill and requires admission to a hospital, either the patient or his General Practitioner contacts the Spinal Injuries Centre. If a bed is available in the Spinal Injuries Centre, the patient is admitted straightaway. However, in situations when a bed is not available in the Spinal Injuries Centre, the patient is admitted to the nearest hospital without delay, and then the tetraplegic patient is transferred to the Spinal Unit as soon as possible. There have been a few instances wherein a chronic tetraplegic patient requiring readmission was admitted to another hospital. These situations may fall under the following categories.

- (1) The patient preferred to go to a local hospital adjacent to his/her home as it would be more convenient for the patient's relatives to visit him/her in the nearby hospital rather than travelling a long distance to the Regional Spinal Injuries Centre at Southport.
- (2) Very rarely, the patient's physician chose to refer the patient to another hospital instead of sending the patient to the Spinal Unit.
- (3) In certain unique circumstances wherein the tetraplegic patient required a sophisticated investigation or a therapeutic procedure such as coronary angiography and angioplasty, the physician at the Regional Spinal Injuries Centre made a decision to send this particular patient to a hospital specialising in that sphere of medicine.

Thus, evaluation of the number of readmission episodes to the Regional Spinal Injuries Centre in this study is an underestimate of the total number of readmission episodes of the tetraplegic patients registered with the Regional Spinal Injuries Centre. However, an assessment of the readmission episodes to the Spinal Unit is likely to provide a pattern of the readmission episodes of chronic tetraplegic patients for planning future requirements of hospital beds and ancillary facilities, medical and nursing staff, and areas where research input needs to be focused for decreasing the morbidity of chronic tetraplegic patients. Therefore, the hospital records of all patients with tetraplegia readmitted between 1 January 1994 and 31 December 1995 to the Regional Spinal Injuries Centre, Southport were analyzed with the above objectives in mind. Readmission was defined for the purposes of this study as admissions other than the very first admission to the Regional Spinal Injuries Centre, Southport.

Results

During the 2-year period, there were 221 episodes of readmissions; 155 tetraplegic patients were readmitted, and 44 of them required more than one readmission. Two tetraplegic patients were readmitted five times during the 2-year period. A 59 year-old male sustained C-5 incomplete tetraplegia following a fall in December 1991. He was admitted five times with lower urinary tract ailments. A 26 year-old male sustained tetraplegia with diaphragmatic paralysis in a road traffic accident 6 years ago. He had bilateral implantation of phrenic pacers. He was readmitted three times for assessment of the phrenic pacer, and twice with chest infection during the 2 year period. The total duration of hospital stay by these tetraplegic patients during the 221 readmission episodes was 3260 days. The tetraplegic patients who were readmitted occupied 4.5 beds in the spinal unit which amounts to 11.5% of the present bed capacity of the Spinal Injuries Centre. Most often, the tetraplegic patients requiring readmission were admitted either to the Intensive Treatment Unit or to the High Dependency Unit of the Regional Spinal Injuries Centre. The hospitalisation charges for admission in the intensive treatment unit are £602 per day whereas the cost of treatment is £450 per day in the high dependency unit.

The disease-wise classification of the readmission episodes of the tetraplegic patients between 1 January 1994 and 31 December 1995 is presented in Table 1. Among the reasons for the readmissions, evaluation and care of urinary tract disorders topped the list with 96 readmission episodes involving 70 patients. (Figure 1). The duration of hospital stay for patients undergoing assessment and/or treatment of urinary tract disorders varied from 1 to 69 days (median: 3 days; mean: 7.9 days). Sixty-five patients stayed 1 to 5 days; 21 remained in the hospital for periods ranging from 6 to 20 days, whereas the period of hospitalisa-

tion was more prolonged in ten cases. Twenty-six per cent of patients required more than one readmission during this period. On an average, one hospital bed was occupied by such a tetraplegic patient requiring treatment/evaluation of urinary tract ailments in the Southport Spinal Injuries Centre between 1 January 1994 and 31 December 1995. The average time interval between the onset of paralysis and the

readmission for assessment/treatment of urinary tract disorders was 12 years with 95% Confidence Interval of 10.2 and 13.9 years. The major urological procedures performed during the readmission phase are classified in Table 2. The changing trend in the clinical practice, and consequently in the pattern of readmissions, is portrayed under 'comments' in Table 2.

Table 1 Disease-wise classification of the readmission episodes of tetraplegic patients who were readmitted to the Regional Spinal Injuries Centre, Southport between 1 January 1994 and 31 December 1995 showing (1) the number of readmission episodes; (2) the number of patients; (3) mean hospital stay in days and (4) the percentage of patients who required more than one readmission

<i>Reasons for readmissions</i>	<i>Number of readmission episodes</i>	<i>Number of patients who were readmitted</i>	<i>Mean duration of hospital stay (days)</i>	<i>Percentage of patients who required more than one readmission</i>	<i>Total number of hospital days during the 2 year period</i>	<i>Bed occupancy (number of beds occupied per year)</i>
Neuro-urological evaluation and/or treatment of urinary tract diseases	96	70	8	26	766	1.0493
Assessment and/or treatment of cardio-respiratory ailments	51	27	18	48	894	1.225
Assessment and/or treatment of neurological disorders	18	15	13	13	229	0.313
Assessment and/or treatment of diseases of the gastro-intestinal system	17	15	11	13	194	0.266
Dysfunction of social milieu compelling a hospital admission	13	9	35	33	455	0.623
Reconstructive surgery	13	8	9	63	112	0.153
Obstetrics/medical/ENT/surgical diseases	6	6	11	0	63	0.086
Pressure sores	7	5	78	40	547	0.749
Total	221	155	14.75	28.38	3260	4.465

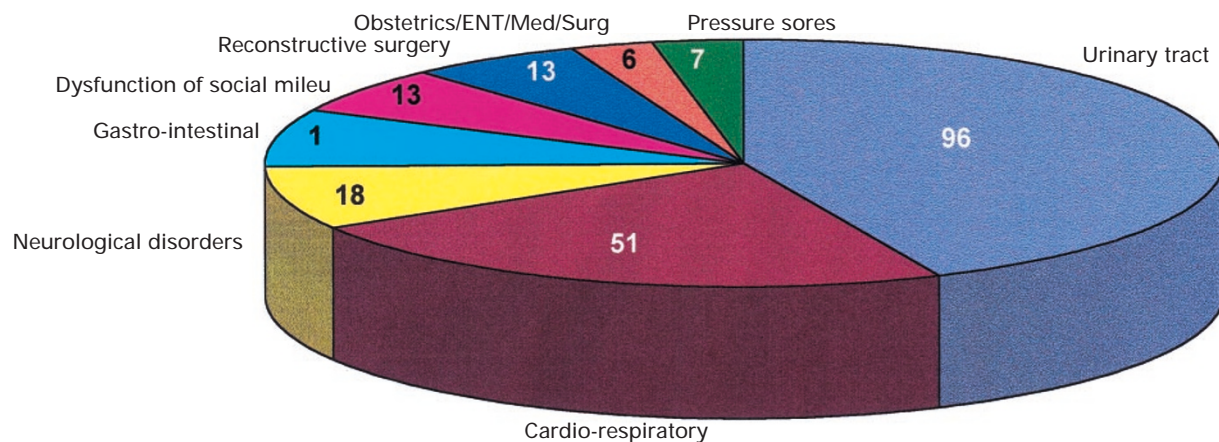


Figure 1 Pie chart shows the disease-wise classification of the readmission episodes of tetraplegic patients who were readmitted to the Regional Spinal Injuries Centre, Southport between 1 January 1994 and 31 December 1995. Evaluation/treatment of urinary tract disorders was the most common indication for a readmission in this group of chronic tetraplegic patients during this period

Table 2 Details of the readmission of tetraplegic patients for evaluation and/or treatment of urinary tract related ailments: Procedures performed with remarks regarding the changing trend in the clinical practice in the management of neuropathic bladder

<i>Reason for readmission</i>	<i>Number of readmission episodes</i>	<i>Average duration of hospital stay (days)</i>	<i>Procedure performed</i>	<i>Comments</i>
Annual urological check-up	16	1.3	Intravenous urography; blood biochemical and haematological tests. Global assessment	Admission becomes necessary for annual check-up in case of those tetraplegic patients who live far away from the hospital, and who are unable to arrive at the hospital by 1100 hours because of social reasons
Surgery for bladder stones	11	4.5	Endoscopic lithotripsy was done in ten patients; suprapubic cystolithotomy was done in one patient	With the availability of flexible cystoscope, cystoscopy is now being performed on out-patient basis, and bladder stones will be detected more readily, thus averting the need for an open operation which requires a prolonged hospital stay
Urinary tract infection	8	3.5	Intravenous antibiotics	With the more frequent use of intermittent catheterisation performed by the carers on tetraplegic patients, serious urinary infection requiring hospital admission is expected to occur less often in future as compared to these figures. Knowledge of the pathophysiology of neuropathic urothelium and cystitis will guide towards generating future therapeutic advances aimed at control of the cellular abnormalities occurring in the vesical mucosa which contribute towards its increased susceptibility for cystitis ⁴
Autonomic dysreflexia	6	14	Treatment of underlying condition which led to development of dysreflexia eg inadequate bladder drainage	One tetraplegic patient was admitted thrice with episodes of bladder-related autonomic dysreflexia. Subsequent to implantation of programmable pump for intrathecal delivery of baclofen, dysreflexic episodes abated. We now prescribe terazosin by mouth to patients who tend to manifest autonomic dysreflexia as terazosin decreases the frequency of occurrence of dysreflexia and reduces the intensity of the dysreflexic episode. Thus we are able to avert an acute episode of dysreflexia requiring an emergency admission of a tetraplegic patient
Haematuria	5	2.4	Cytoscopy	With the availability of flexible cystoscope, cystoscopy is now being performed on out-patient basis, thus avoiding the need for an admission to the hospital in most of the cases
Retention of urine	6	2.5	Urethral Catheterisation/suprapubic cystostomy/repositioning of suprapubic catheter	Majority of these procedures are now performed either as a day case or requiring only overnight admission. In selected patients with catheter-induced urethral trauma, we now insert a new catheter by flexible cystoscopy using a guide wire with favourable clinical outcome ⁵

continued

Table 2 (continued)

<i>Reason for readmission</i>	<i>Number of readmission episodes</i>	<i>Average duration of hospital stay (days)</i>	<i>Procedure performed</i>	<i>Comments</i>
Minor endoscopic operative procedure	9	2	Insertion of ureteric stent (as a preliminary procedure before shock wave lithotripsy of renal stones)/removal of ureteric stent/removal of urethral stent inserted for detrusor-sphincter dyssynergia	The present trend is to perform these procedures as a day case, and only overnight admissions are required in the majority of instances
Major endoscopic operative procedure	6	15.5	Division of external urethral sphincter, Trans-urethral resection of bladder neck, Stamey procedure to minimise urine leak and spontaneous catheter extrusion in a female patient with patulous bladder neck and urethra caused by prolonged indwelling urethral catheter drainage	We now prefer intermittent catheterisation with adjuvant pharmacotherapy (oral or intravesical oxybutynin) to achieve low-pressure, complete emptying of the urinary bladder and a socially acceptable degree of urinary continence. ⁶ We try to avoid long-term indwelling urethral catheter drainage in patients with injury to the spinal cord and neuropathic bladder dysfunction whenever possible
Major neurological operative procedures	12	23.5	Sacral anterior root stimulator (SARS) implantation, tuning of the SARS, percutaneous nephrolithotomy, excision of urethral fistula, cystectomy for bladder cancer	No tetraplegic patient underwent urinary diversion during this period. The tetraplegic patients are happy with the penile sheath drainage, or intermittent catheterisation regime, or indwelling catheter. Review of patients with neuropathic bladder and indwelling catheter drainage for periods greater than 10 years duration, presently includes flexible cystoscopy and bladder biopsy, besides intravenous urography. With this regime, it is hoped that neoplastic transformation will be detected early
Learning intermittent catheterisation	6	2	Teaching the technique of intermittent catheterisation to the patient/carer(s)	As intermittent catheterisation is practised by more number of tetraplegic patients, there is likely to be additional week-end admissions in future for learning the technique of intermittent catheterisation

Assessment and treatment of cardio-respiratory diseases came as the second most common reason for readmission with 51 readmission episodes pertaining to 27 patients with a median hospital stay of 6 days. Forty-eight percent of these patients were readmitted more than once within this 2-year period. The average time interval between the onset of paralysis and the readmission for cardio-respiratory diseases was 11.3 years. Treatment of cardio-respiratory diseases in chronic tetraplegic patients required 1.2 hospital beds on average throughout the year. Chest infection was the commonest respiratory ailment in tetraplegic patients warranting hospital admission; there were 32 episodes of re-admission involving 19 patients. The duration of hospital stay for tetraplegic patients readmitted with chest infection ranged from 2 to 114 days with an average of 23 days. The treatment instituted for chest infection included intravenous antibiotics, salbutamol/ipratropium nebuliser, and chest physiotherapy. Four

tetraplegic patients required readmission for phrenic pacer assessment and diaphragm screening was performed on one patient; there were ten readmission episodes under this category during the 2-year study period. The hospital stay ranged from 2–16 days with an average of 5 days. Replacement of the phrenic pacer receiver block was performed on one tetraplegic patient who stayed in the hospital for 14 days. Chest pain, cardiac failure, or postural hypotension in tetraplegic patients were the reasons for the eight readmission episodes concerning five patients who stayed in the hospital for an average period of 8 days.

Five tetraplegic patients were readmitted for treatment of pressure sores during the 24-month period of this study. The majority of tetraplegic patients with pressure sores were managed successfully by conservative treatment in their home environment. The non-surgical treatment of pressure sores comprised of (i) relief of pressure from the

affected area; (ii) use of appropriate pressure relieving cushion/mattress; (iii) wound care inclusive of regular application of sugar paste in cases of exudative pressure sores and (iv) resolving the associated social and psychological issues wherever possible as these psycho-social problems are often contributory to the pathogenesis of the pressure sore(s) in chronic tetraplegic patients. Among the tetraplegic patients with pressure sore, only those patients who either required surgical repair of the complex pressure sore(s), or who had profound social problems were admitted to the Regional Spinal Injuries Centre. Therefore, this selected group of tetraplegic patients had a prolonged hospital stay (median duration: 101 days). Two patients were readmitted twice for management of pressure sores. During the two readmission episodes, a 25 year-old, female, C-6 tetraplegic patient with a scapular pressure sore, stayed in the hospital for 109 and 110 days respectively. A 25 year-old male patient with left ischial and trochanteric pressure sores remained in the hospital for 107 days and 101 days respectively after undergoing surgical repair of the pressure sores.

Social reasons accounted for 13 readmission episodes concerning nine patients who stayed in the hospital for varying periods (median: 6.5 days; mean: 35 days).

Six patients expired during their readmission. The average time interval between their developing tetraplegia and the final readmission was 14.8 years. The average stay in the hospital before their demise was 13.3 days. Four tetraplegic patients readmitted with acute chest infection expired. A 81 year-old tetraplegic died of myocardial infarction. Urinary sepsis, renal insufficiency, respiratory failure and intra-cerebral haemorrhage accounted for the demise of a 41 year-old tetraplegic patient following surgical removal of a large, impacted stone at the pelviureteric junction. A tetraplegic patient who was admitted with haematuria subsequently underwent cystectomy for squamous cell carcinoma of the urinary bladder; he developed secondaries and expired 5 months later. Three tetraplegic patients who were readmitted with acute chest infection during the study period, recovered and were discharged home in a stable condition. However, they again developed serious chest infection 11 to 25 months after their discharge, and died of respiratory insufficiency.

Discussion

Injury to the cervical spinal cord has been shown to produce prolonged changes in the functional milieu of many organ systems both in experimental animals,⁷ and in human beings. DeVivo and associates presented data to support the contention that early admission to an organised multidisciplinary spinal cord injury care system will lead to reduced mortality, a slightly greater chance of neurological recovery, shorter lengths of stay, lower hospital charges, and a lower incidence of

pressure sores.⁸ Whereas it is generally accepted that patients with injury to the cervical spinal cord should be admitted to a spinal injuries centre immediately after trauma in order to get the ideal treatment and to avoid complications of spinal cord injury, it is not realised that the tetraplegic patients could develop a wide variety of disorders during the chronic phase of their disability requiring readmissions. We recommend that the readmissions of tetraplegics should be to a spinal injuries centre in order to get the special medical and nursing care which they need because of the profoundly altered respiratory, vesico-renal, gastrointestinal, and skin functions. Further, spinal cord injury may modify the typical symptoms and signs of an illness irrespective of whether the illness is a complication of the injury or unrelated to it. A tetraplegic patient may present with an acute abdominal condition without displaying tenderness in the abdomen, a femoral fracture without pain, and deep venous thrombosis without tenderness in the calf.⁹ Conversely, unique symptoms or signs may signify the presence of a serious disease. Increased spasms and/or sweating may be the presenting symptom of acute urinary infection in a tetraplegic patient; the symptomatology may be baffling to the uninitiated medical and nursing staff. Prompt and accurate diagnosis and treatment is more likely to happen in specialised spinal injury centres where the health professionals are trained to look after these patients with specific needs. Needless to say, when tetraplegic patients attend a general hospital even for an emergency medical condition eg a blocked urethral catheter with autonomic dysreflexia, a delay in diagnosis and treatment can produce irreparable damage, eg intra-cerebral haemorrhage due to acute hypertension associated with autonomic dysreflexia.

Cardio-respiratory diseases (acute chest infection culminating in respiratory failure, pulmonary embolism, and myocardial infarction) and urinary tract disorders (kidney stones, urinary sepsis, renal insufficiency, and bladder cancer) were the leading causes of death in chronic tetraplegic subjects requiring readmission in this study. In an American collaborative study,¹⁰ the leading primary causes of death during the first 12 years after spinal cord injury were pneumonia, non-ischaemic heart disease, and septicemia. DeVivo and associates observed that spinal cord injured persons were 82.2 times more likely to die of septicemia, 46.9 times more likely to die of pulmonary emboli, and 37.1 times more likely to die of pneumonia than comparable individuals from the general population.¹⁰

This study covering a period of 2 years show that 4.5 hospital beds need to be reserved in the Regional Spinal Injuries Centre, Southport for the care of tetraplegic patients requiring re-admission in the north-west of England. As more patients with high cervical spinal cord injury survive the initial period of trauma, and as the life expectancy of tetraplegic patients increases, a greater number of tetraplegic

patients will be requiring readmission to spinal injuries centre. Further, the Southport Spinal Injuries Centre provides comprehensive care to some of the ventilator-dependent tetraplegic patients of other regions. Therefore, additional allocation of beds, health professionals, and facilities will be required in future for providing optimum care to chronic tetraplegic patients at this centre.

As each episode of readmission results in considerable expenditure to the health services, the Southport Spinal Injuries Centre has now implemented the following three innovative measures to reduce the need for a readmission of a chronic tetraplegic patient.

(1) Open door policy

The Southport Spinal Injuries Centre is presently adopting an open door policy by which all patients registered with the Centre can come to the hospital without prior appointment 7 days a week, for advice, clinical examination, and treatment of any urgent health-related issues. By adopting this strategy, many tetraplegic patients are able to seek guidance and treatment for a medical problem at an early stage, say for example, urinary infection or respiratory ailment. The team of health professionals in the Spinal Injuries Centre then get in touch with the community health care staff and activate the additional medical, nursing, and social care which a tetraplegic patient may require temporarily during the period of the illness. For examples, the staff of the spinal unit take steps to arrange extra home help to a tetraplegic patient with acute soft tissue infection restricting his/her independent living. Similarly, nebuliser therapy with a jet nebuliser using an electrical compressor for delivering a beta-adrenoceptor stimulant or ipratropium is made available in the home environment by the staff of the spinal unit to tetraplegic patients with acute chest infection and reversible airway obstruction. As tetraplegic subjects suffer from unopposed cholinergic broncho-constrictor activity due to loss of sympathetic innervation of the airway, and a resultant increase in resting airway tone, bronchodilator agents provide a significant improvement in forced expired volume in 1 second and/or forced vital capacity.¹¹ Thus, bronchodilator administered in the community together with chest physiotherapy and antibiotics, may tide over the crisis in a tetraplegic patient with acute chest infection, and avert the need for an admission to a hospital.

(2) Telephonic advice where appropriate

Similarly, the health professionals in the Spinal Injuries Centre are available for providing advice, and discussing urgent health-related issues of the patients registered with the Centre over the telephone with the patient, carers, and community health professionals eg district nurse 24 h a day. On an average, ten patients are attended to in the above manner during a week day; this has helped tremendously to improve the care

of tetraplegic patients in the community, and avoid the necessity for a hospital attendance in a significant number of cases.

(3) Home visits by the staff of the centre

Analogously, the health professionals, especially the nursing and medical staff visit the patients in their home environment thus averting the need for transportation of a severely disabled patient to a hospital. Most of the patients with pressure sores are now being managed in their home environment in liaison with the General Practitioner and the District Nurse with the expert advice provided by the Centre staff who make regular home visits to assess these patients.

With the adoption of the above-mentioned measures as practised by the staff of the Spinal unit, the demand for a hospital readmission of patients with injury to the cervical spinal cord will be hopefully reduced. However, for veterans discharged from Veterans Affairs hospitals, the primary care intervention increased rather than decreased the rate of rehospitalization, although patients in the intervention group were more satisfied with their care.¹² A follow-up study of readmissions of chronic tetraplegics to the Regional Spinal Injuries Centre, Southport will reveal whether by providing immediate access for medical care by means of telephonic contact, home visits, and open door policy, we are pursuing the medical problems of chronic tetraplegics in greater depth. If we look more often, and look harder, we may find more potential diseases, which could lead to more hospitalizations.¹³ However, we believe that by instituting suitable preventive strategies, and by prompt diagnosis and treatment during the early stage of a disease process for example, acute urinary infection or pressure marks, the progress of the illness is arrested and the morbidity is greatly reduced. Indeed, we have noticed an improvement in the quality of life of chronic tetraplegic patients of our centre subsequent to the adoption of 'open-door policy.'

Nevertheless, it is envisaged that advances in medical expertise will lead to a different pattern of readmissions of tetraplegic patients in the coming years. With the availability of new implants, and their expanded use, eg (1) programmable pump for intrathecal delivery of baclofen for control of intractable spasticity; (2) sacral anterior root stimulator for micturition, bowel evacuation, and penile erection; (3) implantable phrenic pacer for tetraplegic patients with high cervical lesion resulting in supra-nuclear diaphragmatic paralysis and (4) implantation of a prosthesis for functional electrical stimulation of upper limb muscles, chronic tetraplegic patients will require readmission for undergoing these procedures which are likely to improve the quality of life. We are witnessing the changing scenario wherein a tetraplegic patient is seldom admitted now with acute urinary

infection (see comments in Table 2), but a well-settled tetraplegic patient may require readmission for undergoing an implant to improve his/her quality of life.

Thus in future, tetraplegic patients will be readmitted for an elective procedure after recovery from the effects of initial trauma and resettlement in the community, for reaping the benefits of the advances in medical technology which are being rapidly translated into routine clinical practice of spinal cord injury medicine, thus making additional and unconventional demands on hospital beds, health professional manpower, and ancillary facilities of a spinal injury centre. Further, clinical research pertaining to spinal cord regeneration, and therapeutic drug trials of pharmaceutical products especially those related to spinal cord injury medicine, will demand admissions albeit for short spells, of patients with cervical spinal injury who are willing to participate in innovative therapeutic procedures.

Understandably, some of these research projects will be funded by the pharmaceutical and biotechnology firms; but the spinal injury centre *per se*, may be developing a clinical protocol with the prior approval of the Research Ethics Committee. Thus, while making contracts with purchasers for providing optimum care to the patients with injury to the spinal cord, projection for the future should include the changing scenario in the pattern of readmissions.

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