ORIGINAL ARTICLE

Traumatic and nontraumatic spinal-cord-injured patients in Quebec, Canada. Part 3: pharmacological characteristics

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Study design: Community-based, cross-sectional study.

Objectives: This study aimed at examining and comparing the pharmacological treatments administered to traumatic and nontraumatic spinal-cord-injured patients (TSCI, NTSCI).

Setting: The Interval Rehabilitation Center, Trois-Rivieres, Province of Quebec, Canada.

Methods: Medical records from a cohort of 175 chronic spinal-cord-injured patients (94 TSCI and 81 NTSCI individuals) were thoroughly studied.

Results: More than 19 classes and more than 300 drugs were found to be administered to SCI patients. Among them, drugs against bowel and bladder problems, blood clot or deep venous thrombosis, cardiovascular problems, depression or anxiety, stomach acidity, infections, pain, inflammation, sleeping problems and vitamin deficiency were the most commonly used (between 35 and 66% of all SCI patients). Differences between groups were found specifically for antidepressants and anxiolytics used mainly by TSCI patients whereas bisphosphonates, bronchodilators, lipid regulators and anti-inflammatory drugs were used mainly by NTSCI patients.

Conclusion: The results revealed an unexpectedly large number of drugs that are prescribed to both groups of SCI patients. Given the existence of between-group differences and known risks of drug–drug interactions, it is suggested that recommendations for each group should be made to carefully examine either the necessity or the effectiveness of each treatment as well as the possibility of developing alternative strategies based on physical activity, nutrition and lifestyle to eventually reduce, hopefully, the number of pharmacological treatments administered to these individuals.

Spinal Cord (2011) **49**, 186–195; doi:10.1038/sc.2010.70; published online 15 June 2010

Keywords: spinal cord injury; drugs; treatments; chronic; pharmacology

Introduction

Traumatic spinal-cord-injured (TSCI) and nontraumatic spinal-cord-injured (NTSCI) patients typically undergo an irreversible loss of sensory and voluntary motor functions and experience multiple health problems (see companion article no. 1).¹ SCI patients are known to receive a variety of pharmacological treatments for these health problems. However, differences between TSCI and NTSCI patients in this regard remain unclear. Given the increasingly clear specificity of these groups and subgroups of patients (for example, epidemiologically, functionally, biochemically, see companion articles),^{1,2} it may be expected that pharmacological treatments administered to TSCI and NTSCI patients should be specifically adapted and, thus, different in each group and subgroups of SCI patients. Here, the main

aim was to assess and directly compare in a relatively homogenous community (Trois-Rivieres City, Quebec, Canada), the list of drugs and drug classes prescribed to or used by TSCI and NTSCI patients. This article is the third of a series of three articles aimed to describe the epidemiological, clinical, functional (first article)¹ and biochemical (second article)² characteristics associated with TSCI and NTSCI patients.

Materials and methods

This protocol was approved by the institution from where the medical records were obtained (Interval Rehabilitation Center, Trois-Rivieres, Quebec, Canada) as well as by an independent ethic committee (International Review Board Services, Aurora, Ontario, Canada). We studied data from male (97) and female (54) patients ($n=151$) from the Interval Rehabilitation Center that have been SCI traumatically (82 patients; paraplegic incomplete (22 men and 7 women), paraplegic complete (13 men and 2 women),

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Received 4 December 2009; revised 7 May 2010; accepted 9 May 2010; published online 15 June 2010

tetraplegic incomplete (14 men and 8 women) tetraplegic complete (9 men and 3 women) and unknown (2 men and 2 women) or nontraumatically (69 patients; paraplegic incomplete (16 men and 18 women), paraplegic complete (1 man and no woman), tetraplegic incomplete (19 men and 14 women) tetraplegic complete (no one) and unknown (1 man and no woman) for at least 1 year and typically less than 10 years. For additional methodological details, refer to companion articles.^{1,2} All drugs assessed were classified by classes (utility) and reported as incidences.

Results

Bone and muscle loss

The results showed that drugs typically used for osteopenia and osteoporosis were administered to a significant number of TSCI and NTSCI patients (Table 1). Among these drugs, bisphosphonates, such as alendronate sodium (Fosamax) and risedronate (Actonel), raloxifene (Evista, estrogen receptor ligand), calcitonin salmon (Miacalcin), disodium pamidronate (Aredia) and calcium carbonate (Calcite), were prescribed to 13.2% of all SCI patients. However, clearly more NTSCI (20.3%) than TSCI patients (7.3%) received this class of medication. It is worth mentioning also that among all SCI patients, the incidence was particularly high in women (25.9% of all SCI women) compared with men (only 6.2% of all SCI men). In turn, no drugs against skeletal

muscle loss or so-called muscle wasting were administered to these patients.

Bowel and bladder problems

We found several compounds normally used to treat bowel problems (typically constipation) as well as to improve bladder function (Tables 2 and 3). In fact, laxatives were by far the most often prescribed class of medication among all drugs and classes administered to these SCI patients. A total of 265 prescriptions were made for drugs such as docusate sodium (Docusate/Colace, 26.8%), senna glycosides (Senokot, 18.5%), bisacodyl (Dulcolax, 15.8) and glycerin suppository (13.6%). More TSCI patients (73.2%) were given laxatives compared with NTSCI patients (43.5%), suggesting that this particular problem was more often encountered after chronic TSCI. A total of 71 prescriptions for bladder function (specifically diuretics) were found among all SCI medical records (Table 3). Among all TSCI and NTSCI patients, respectively 40.2 and 34.8% of them received a diuretic such as oxybutynin chloride (Ditropan, 42.3% of all diuretics), hydrochlorothiazide (Apo-hydro, 16.9%) and tolterodine L-tartrate (Detrol, 8.5%). The subgroup that most often received diuretics was by far the complete TSCI paraplegic patients (73.3% of all TSCI paraplegics; Table 3).

Blood (anemia) and coagulation problems

Anemia is a well-recognized problem found after SCI typically in the acute and early chronic phases (see

Table 1 Drugs against bone loss

	TSCI		NTSCI		SCI	
	Bone loss treatment (n = 6)	No bone loss treatment (n = 76)	Bone loss treatment (n = 14)	No bone loss treatment (n = 55)	Bone loss treatment (n = 20)	No bone loss treatment (n = 131)
Male	5.0	95.0	8.1	91.9	6.2	93.8
Female	13.6	86.4	34.4	65.6	25.9	74.1
Incomplete paraplegia	0	100	26.5	73.5	14.3	85.7
Complete paraplegia	13.3	86.7	0	100	12.5	87.5
Incomplete tetraplegia	13.6	86.4	15.2	84.8	14.5	85.5
Complete tetraplegia	0	100	0	0	0	100

Abbreviations: NTSCI, nontraumatic spinal cord injured; SCI, spinal cord injury; TSCI, traumatic spinal cord injured. Mainly calcium supplements and bisphosphonates.

Table 2 Drugs for bowel and bladder problems

	TSCI		NTSCI		SCI	
	Laxative (n = 60)	No laxative (n = 22)	Laxative (n = 30)	No laxative (n = 39)	Laxative (n = 90)	No laxative (n = 61)
Male	75.0	25.0	43.2	56.8	62.9	37.1
Female	72.7	27.3	43.8	56.2	55.6	44.4
Incomplete paraplegia	69.0	31.0	52.9	47.1	60.3	39.7
Complete paraplegia	93.3	6.7	0	100	87.5	12.5
Incomplete tetraplegia	72.7	27.3	36.4	63.6	50.9	49.1
Complete tetraplegia	83.3	16.7	0	0	83.3	16.7

A total of 265 prescriptions found in 57 medical records (mainly laxatives).

Table 3 Drugs for bladder function

	TSCI		NTSCI		SCI	
	Diuretic (n = 33)	No diuretic (n = 49)	Diuretic (n = 24)	No diuretic (n = 45)	Diuretic (n = 57)	No diuretic (n = 94)
Male	38.3	61.7	35.1	64.9	40.2	59.8
Female	45.5	54.5	34.4	65.6	38.9	61.1
Incomplete paraplegia	20.7	79.3	41.2	58.8	31.7	68.3
Complete paraplegia	73.3	26.7	0	100	68.8	31.2
Incomplete tetraplegia	36.4	63.6	27.3	72.7	30.9	69.1
Complete tetraplegia	50.0	50.0	0	0	50.0	50.0

A total of 71 prescriptions found in 57 medical records (mainly diuretics).

Table 4 Drugs against anemia

	TSCI		NTSCI		SCI	
	Antianemic (n = 12)	No antianemic (n = 70)	Antianemic (n = 6)	No antianemic (n = 63)	Antianemic (n = 18)	No antianemic (n = 133)
Male	15.0	85.0	8.1	91.9	12.4	87.6
Female	13.6	86.4	9.4	90.6	11.1	88.9
Incomplete paraplegia	13.8	86.2	8.8	91.2	11.1	88.9
Complete paraplegia	20.0	80.0	0	100	18.8	81.2
Incomplete tetraplegia	4.5	95.5	9.1	90.9	7.3	92.7
Complete tetraplegia	25.0	75.0	0	0	25.0	75.0

A total of 19 prescriptions found in 18 medical records (iron supplements).

Table 5 Drugs against blood clots and DVT

	TSCI		NTSCI		SCI	
	Anti coagulants (n = 28)	No anticoagulants (n = 54)	Anticoagulants (n = 23)	No anticoagulants (n = 46)	Anticoagulants (n = 51)	No anticoagulants (n = 100)
Male	33.3	66.7	32.4	67.6	33.0	67.0
Female	31.8	68.2	34.4	65.6	33.3	66.7
Incomplete paraplegia	31.0	69.0	44.1	55.9	38.1	61.9
Complete paraplegia	40.0	60.0	0	100	37.5	62.5
Incomplete tetraplegia	36.4	63.6	24.2	75.8	29.1	70.9
Complete tetraplegia	33.3	66.7	0	0	33.3	66.7

A total of 55 prescriptions found in 51 medical records (mainly anticoagulants).

companion article no. 1). We found two classes of drugs administered to both TSCI and NTSCI patients, namely the iron supplements (Table 4) and anticoagulating compounds (Table 5). Approximately one patient out of ten (11.9%) received ferrous sulfate (FeSO_4) or ferrous fumarate (Palafer) after TSCI (8%) and NTSCI (14%) (Table 4). In contrast, about one-third of all SCI patients (34.1% TSCI and 33.3% NTSCI) received anticoagulants such as heparin sodium (Heparin), enoxaparin sodium (Lovenox), warfarin sodium (Coumadin) or dalteparin sodium (Fragmin) (Table 5).

Cardiovascular problems and dyslipidemia

Cardiovascular problems include a rather large group of different drugs. In this study, it included treatments such as calcium channel blockers (for example, amlodipine besylate

(Norvasc), diltiazem HCl (Cardizem), β -blockers (for example, bisoprolol fumarate (Monacor), metoprolol tartrate (Lopressor), angiotensin-converting enzyme inhibitors (ramipril (Altace), fosinopril sodium (Monopril), angiotensin II receptor antagonists and other antihypertensive drugs (α -2 agonists, diuretic/antihypertensive drugs) among the most popular ones (Table 6). Nearly one-third of all SCI patients (34.4%) received a drug for cardiovascular problems. Indeed a significant proportion of TSCI (29.3%) and NTSCI (40.6%) patients with nearly as many men and women received at least one of the so-called cardiovascular treatments. Their use did not apparently depend on the completeness or level of injury (ranging between 25.7 and 41.8% in each subgroup—for example, 33.3% of all complete SCI patients received at least one of these drugs). However, one of the main risk factors associated with

Table 6 Drugs for heart and blood vessel functions

	TSCI		NTSCI		SCI	
	Cardiovascular drugs (n = 24)	No cardiovascular drugs (n = 58)	Cardiovascular drugs (n = 28)	No cardiovascular drugs (n = 41)	Cardiovascular drugs (n = 52)	No cardiovascular drugs (n = 99)
Male	31.7	68.3	43.2	56.8	36.1	63.9
Female	22.7	77.3	37.5	62.5	31.5	68.5
Incomplete paraplegia	27.6	72.4	32.4	67.6	30.2	69.8
Complete paraplegia	26.7	73.3	0	100	25.0	75.0
Incomplete tetraplegia	33.3	66.7	48.5	51.5	41.8	58.2
Complete tetraplegia	33.3	66.7	0	0	33.3	66.7

Widely used drugs including calcium channel antagonists, antihypertensive drugs, angiotensin-converting enzyme inhibitors among the most popular found in 52 medical records.

Table 7 Drugs for lipid regulation

	TSCI		NTSCI		SCI	
	Lipid regulators (n = 10)	No lipid regulators (n = 72)	Lipid regulators (n = 15)	No lipid regulators (n = 54)	Lipid regulators (n = 25)	No lipid regulators (n = 126)
Male	15.0	85.0	37.8	62.2	23.7	76.3
Female	4.5	95.5	3.1	96.9	3.7	96.3
Incomplete paraplegia	10.3	89.7	20.6	79.4	15.9	84.1
Complete paraplegia	13.3	86.7	100	0	18.8	81.2
Incomplete tetraplegia	13.6	86.4	21.2	78.8	18.2	81.8
Complete tetraplegia	8.3	91.7	0	0	8.3	91.7

A total of 25 medical records found with lipid regulators such as atorvastatin calcium, rosuvastatin calcium or simvastatin.

Table 8 Diabetic drugs

	TSCI		NTSCI		SCI	
	Diabetes (n = 7)	No diabetes (n = 75)	Diabetes (n = 15)	No diabetes (n = 54)	Diabetes (n = 22)	No diabetes (n = 129)
Male	5.0	95.0	29.7	70.3	14.4	85.6
Female	18.2	81.8	12.5	87.5	14.8	85.2
Incomplete paraplegia	3.4	96.6	23.5	76.5	14.3	85.7
Complete paraplegia	6.7	93.3	100	0	12.5	87.5
Incomplete tetraplegia	13.6	86.4	18.2	81.8	16.4	83.6
Complete tetraplegia	8.3	91.7	0	0	8.3	91.7

A total of 22 medical records found with antidiabetic compounds such as insulin (type I diabetes) or regulators of glycemia (type II diabetes).

cardiovascular problems is dyslipidemia. Consequently, it is not surprising to find that many SCI patients were also given drugs to control serum lipid levels. A significant number of SCI patients (16.6%) received at least one drug of this class (Table 7). Among the most popular treatments, we found fenofibrate (Lipidil) and statins, such as atorvastatin calcium (Lipitor, 66.7% of all drugs in this class), simvastatin (Zocor), pravastatin sodium (Pravachol) and rosuvastatin calcium (Crestor), used by 12.2% of TSCI and 21.8% of NTSCI patients (again, no complete NTSCI patients received drugs from this class).

Diabetes

Type II diabetes is well known to occur in chronic SCI patients. The results showed that 14.6% of all patients in this

study received at least one treatment against type I (for example, insulin) or most typically against type II diabetes (that is, generally acting on hyperglycemia) including biguanides (metformin chloride), glibenclamide or sulfonylureas (Diabeta), pioglitazone (actos), gliclazide (diamicon), rosiglitazone (Avandia), sulfonylureas (tolbutamide, sympathomimetic drug) (Table 8). A clear difference was found between groups as 8.5% of TSCI and 21.7% of NTSCI patients received at least one of these drugs.

Depression

The results revealed that a significant proportion of SCI patients were treated for depression or anxiety (Table 9). Indeed, 38.4% of them received at least one antidepressant or anxiolytic drug. Interestingly, the proportion of patients

Table 9 Drugs for mood disorders

	TSCI		NTSCI		SCI	
	Antidepressant (n = 41)	No antidepressant (n = 41)	Antidepressant (n = 17)	No antidepressant (n = 52)	Antidepressant (n = 58)	No antidepressant (n = 93)
Male	50.0	50.0	21.6	78.4	39.2	60.8
Female	50.0	50.0	28.1	71.9	37.0	63.0
Incomplete paraplegia	34.5	65.5	23.5	76.5	28.6	71.4
Complete paraplegia	80.0	20.0	100.0	0.0	81.3	18.7
Incomplete tetraplegia	57.1	42.9	18.8	81.2	34.0	66.0
Complete tetraplegia	50.0	50.0	0	0	50.0	50.0

A total of 58 medical records found with antidepressant or anxiolytics such as tricyclic amitriptylines, selective serotonin reuptake inhibitors and monoamine oxidase inhibitors.

Table 10 Drugs for respiratory problems

	TSCI		NTSCI		SCI	
	Bronchodilator (n = 7)	No bronchodilator (n = 75)	Bronchodilator (n = 14)	No bronchodilator (n = 55)	Bronchodilator (n = 21)	No bronchodilator (n = 130)
Male	11.7	88.3	16.2	83.8	13.4	86.6
Female	0	100	25.0	75.0	14.8	85.2
Incomplete paraplegia	0	100	17.6	82.4	9.5	90.5
Complete paraplegia	13.3	86.7	0	100	12.5	87.5
Incomplete tetraplegia	13.6	86.4	24.2	75.8	20.0	80.0
Complete tetraplegia	8.3	91.7	0	0	8.3	91.7

A total of 21 medical records found with prescriptions of bronchodilators (e.g., salbutamol sulfate, fluticasone/salmeterol etc.).

Table 11 Dermatitis treatments

	TSCI		NTSCI		SCI	
	Inflammatory dermatosis (n = 8)	No inflammatory dermatosis (n = 74)	Inflammatory dermatosis (n = 4)	No inflammatory dermatosis (n = 65)	Inflammatory dermatosis (n = 12)	No inflammatory dermatosis (n = 139)
Male	11.7	88.3	8.1	91.9	10.3	89.7
Female	4.5	95.5	3.1	96.9	3.7	96.3
Incomplete paraplegia	3.4	96.6	2.9	97.1	3.2	96.8
Complete paraplegia	13.3	86.7	0	100	12.5	87.5
Incomplete tetraplegia	18.2	81.8	9.1	90.9	12.7	87.3
Complete tetraplegia	8.3	91.7	0	0	8.3	91.7

Twelve medical records found with prescriptions of anti-inflammatory dermatosis (e.g., urea 20%).

receiving some of these drugs was greater in the TSCI group (50.0%) than the NTSCI group (24.6%). No clear differences between men and women or between injury level and completeness were found.

Respiratory problems (bronchodilators)

The control breathing and other respiratory problems (infection or inflammation related) are often found in tetraplegic and high paraplegic patients. Here, we identified that 13.9% of all SCI patients were given bronchodilators (generally β -2 agonists, anticholinergic drugs and/or corticosteroids) such as salbutamol sulfate (Ventolin, 51.6% of all bronchodilators), fluticasone/salmeterol (Advair), glucocorticoid (Pulmicort), terbutaline (Bricanyl), tiotropium (Spiriva) and others (Table 10). It was found that 8.5% of

TSCI patients and 20.2% of NTSCI patients received at least one of these drugs.

Skin problems (inflammatory dermatosis)

We found in this study that treatments such as anti-inflammatory drugs were used to treat inflammatory dermatosis. Among them, we identified urea 20% (Uremol), corticosteroid (Betaderm), betamethasone valerate (Celestoderm), fluocinonide emollient cream (Tiamol) and desoximetasone (Topicort), which were occasionally administered to 9.7% of TSCI and 5.7% of NTSCI patients (Table 11).

Stomach acidity

Acid stomach problems were treated in a significant proportion of SCI patients (35.1%; Table 12). Proton pump

Table 12 Drugs for stomach problems

	TSCI		NTSCI		SCI	
	Antacid (n = 28)	No antacid (n = 54)	Antacid (n = 25)	No antacid (n = 44)	Antacid (n = 53)	No antacid (n = 98)
Male	33.3	66.7	40.5	59.5	36.1	63.9
Female	36.4	63.6	28.1	71.9	31.5	68.5
Incomplete paraplegia	27.6	72.4	47.1	52.9	38.1	61.9
Complete paraplegia	53.3	46.7	0	100	50.0	50.0
Incomplete tetraplegia	38.1	61.9	48.5	51.5	45.3	54.7
Complete tetraplegia	33.3	66.7	0	0	33.3	66.7

A total of 65 prescriptions found in 53 medical records (mainly antacids).

Table 13 Drugs for thyroid problems

	TSCI		NTSCI		SCI	
	Thyroid disease (n = 4)	No thyroid disease (n = 78)	Thyroid disease (n = 7)	No thyroid disease (n = 62)	Thyroid disease (n = 11)	No thyroid disease (n = 140)
Male	5.0	95.0	10.8	89.8	7.2	92.8
Female	4.5	95.5	9.4	90.6	7.4	92.6
Incomplete paraplegia	0.0	100	11.8	88.2	6.3	93.7
Complete paraplegia	13.3	86.7	0	100	12.5	87.5
Incomplete tetraplegia	9.1	90.9	9.1	90.9	9.1	90.9
Complete tetraplegia	0.0	100	0	0	0	100

Eleven medical records found with thyroid hormone replacement treatments (exclusively levothyroxine).

Table 14 Drugs for vitamin deficiency

	TSCI		NTSCI		SCI	
	Supplement vitamins and mineral (n = 17)	No supplement vitamins and mineral (n = 65)	Supplement vitamins and mineral (n = 28)	No supplement vitamins and mineral (n = 41)	Supplement vitamins and mineral (n = 45)	No supplement vitamins and mineral (n = 106)
Male	23.3	76.7	37.8	62.2	28.9	71.1
Female	13.6	86.4	43.8	56.2	31.5	68.5
Incomplete paraplegia	13.8	86.2	38.2	61.8	27.0	63.0
Complete paraplegia	26.7	73.3	0	100	25.0	75.0
Incomplete tetraplegia	22.7	77.3	42.4	57.6	34.5	65.5
Complete tetraplegia	25.0	75.0	0	0	25.0	75.0

A total of 45 medical records found with vitamin supplements (mainly calcium carbonate, multivitamin, potassium chloride, vitamin D and vitamin B₁).

inhibitors such as pantoprazole sodium (Pantoloc, 40% of the prescription in this class) and esomeprazole magnesium (Nexium) as well as other subtypes including ranitidine hydrochloride (Zantac, histamine antagonist) or aluminum hydroxide (Maalox) were among the most frequently found antacid treatments.

Thyroid problems

We found 7.2% of all patients were given levothyroxine (Synthroid), a synthetic thyroid hormone replacement treatment (Table 13). A comparable number of TSCI (4.8%) and NTSCI patients (10.1%) received at least one of these drugs.

Vitamin deficiency

A large proportion of SCI patients (29.8%) were given vitamin supplements probably to treat vitamin deficiencies. Among them, we found calcium carbonate (24.5% of all compounds in this class), multivitamins (Centrum and Fortamines 10, 17.8%), potassium chloride (16.4%), vitamin D (15.1%), vitamin B₁ (12.3%) and others. More NTSCI (40.5%) than TSCI (20.7%) patients received one of these supplements (Table 14).

Chronic pain, sleep disorders and benzodiazepines

This class of drugs was among the most commonly prescribed compounds found in this study. A majority of

Table 15 Opioids

	TSCI		NTSCI		SCI	
	Opioids (n = 48)	No opioids (n = 34)	Opioids (n = 39)	No opioids (n = 30)	Opioids (n = 87)	No opioids (n = 64)
Male	60.0	40.0	64.9	35.1	61.9	38.1
Female	54.5	45.5	46.9	53.1	50.0	50.0
Incomplete paraplegia	69.0	31.0	55.9	44.1	61.9	38.1
Complete paraplegia	60.0	40.0	100	0	62.5	37.5
Incomplete tetraplegia	54.5	45.5	57.6	42.4	56.4	43.6
Complete tetraplegia	41.7	58.3	0	0	41.7	58.3

A total of 148 prescriptions found in 87 medical records with opioids including hydromorphone HCl, acetaminophen-codeine phosphate, morphine sulfate and others.

Table 16 Benzodiazepines

	TSCI		NTSCI		SCI	
	Benzodiazepine drugs (n = 41)	No benzodiazepine drugs (n = 41)	Benzodiazepine drugs (n = 36)	No benzodiazepine drugs (n = 33)	Benzodiazepine drugs (n = 77)	No benzodiazepine drugs (n = 74)
Male	46.7	53.3	51.4	48.6	48.5	51.5
Female	59.1	40.9	56.3	43.7	57.4	42.6
Incomplete paraplegia	41.4	58.6	64.7	35.3	54.0	46.0
Complete paraplegia	46.7	53.3	100	0	50.0	50.0
Incomplete tetraplegia	54.5	45.5	39.4	60.6	45.5	54.5
Complete tetraplegia	50.0	50.0	0	0	50.0	50.0

A total of 77 medical records with benzodiazepines.

Table 17 Drugs for mild pain and fever

	TSCI		NTSCI		SCI	
	Mild pain/fever drugs (n = 51)	No mild pain/ fever drugs (n = 31)	Mild pain/fever drugs (n = 39)	No mild pain/ fever drugs (n = 30)	Mild pain/fever drugs (n = 90)	No mild pain/ fever drugs (n = 61)
Male	65.0	35.0	62.2	37.8	63.9	36.1
Female	54.5	45.5	50.0	50.0	51.9	48.1
Incomplete paraplegia	58.6	41.4	61.8	38.2	60.3	39.7
Complete paraplegia	66.7	33.3	100	0	68.8	32.2
Incomplete tetraplegia	68.2	31.8	51.5	48.5	58.2	41.8
Complete tetraplegia	66.7	33.3	0	0	66.7	33.3

A total of 116 prescriptions found in 90 medical records with drugs including acetaminophen, acetylsalicylic acid and ibuprofen.

SCI were (57.6%) given pain killers (often to reduce sleeping disorders) such as hydromorphone HCl (Dilaudil, 33.1% in this class), acetaminophen-codeine phosphate (Empracet, 17.6%), morphine sulfate (Morphine, 16.2%), codeine sulfate (Codeine, 7.4%) and others (Table 15). No clear differences between men and women or between subgroups associated with the extent or completeness of lesion were found. A comparable proportion of TSCI (58.5%) and NTSCI (56.5%) patients received drugs from this class. Benzodiazepines (Table 16) were often prescribed to treat sleeping problems. It constituted one of the most widely used class of medication in this study with 51% of all SCI patients who receive at least one of these drugs. Approximately as many TSCI (50% of this group) and NTSCI (52% of this group) patients were given this type of medication, strongly suggesting that sleeping problems were typically found in both groups of SCI patients.

Mild pain and fever

Almost 60% (59.6%) of all SCI patients were found to receive acetaminophen (Tylenol), acetylsalicylic acid (for example, Aspirin) or ibuprofen (Advil). Again, no clear differences between men and women or injury level/extent were found (Table 17).

Infections

Nearly one-third of all SCI patients received either an antibacterial (93 prescriptions), antifungal (16 prescriptions) or antiviral (3 prescriptions) medication (Table 18). Forty percent (40%) of TSCI and 34.8% of NTSCI patients were given one of these drugs. In this class of compounds, a clear trend was found to be associated with the extent of injury as most patients that received them had complete lesion (73.3 and 83.3% among the subgroups of patients with complete paraplegia and tetraplegia, respectively).

Table 18 Drugs against infections

	TSCI		NTSCI		SCI	
	Anti-infection drugs (n = 33)	No anti-infection drugs (n = 49)	Anti-infection drugs (n = 24)	No anti-infection drugs (n = 45)	Anti-infection drugs (n = 57)	No anti-infection drugs (n = 94)
Male	46.7	53.3	32.4	67.6	42.2	58.8
Female	45.5	54.5	37.5	62.5	40.7	59.3
Incomplete paraplegia	31.0	69.0	47.1	52.9	39.7	60.3
Complete paraplegia	73.3	26.7	100	0	75.0	25.0
Incomplete tetraplegia	33.3	66.7	21.9	78.1	26.4	73.6
Complete tetraplegia	83.3	17.7	0	0	83.3	17.7

A total of 112 prescriptions found in 57 medical records with antibacterial, antifungal or antiviral drugs.

Table 19 Drugs against inflammation

	TSCI		NTSCI		SCI	
	Anti-inflammatory drugs (n = 19)	No anti-inflammatory drugs (n = 63)	Anti-inflammatory drugs (n = 29)	No anti-inflammatory drugs (n = 40)	Anti-inflammatory drugs (n = 48)	No anti-inflammatory drugs (n = 101)
Male	20.0	80.0	43.2	56.8	28.9	71.1
Female	31.8	68.2	40.6	59.4	37.0	63.0
Incomplete paraplegia	24.1	75.9	47.1	52.9	36.5	63.5
Complete paraplegia	26.7	73.3	0	100	25.0	75.0
Incomplete tetraplegia	18.2	81.8	39.4	60.6	30.9	69.1
Complete tetraplegia	25.0	75.0	0	0	25.0	75.0

A total of 48 medical records with anti-inflammatory drugs.

Inflammations

Drugs against inflammation were either nonsteroidal anti-inflammatory drugs (such as naproxen sodium (Anaprox), naproxen (Naprosyn), indomethacin (Indotec), corticosteroids (for example, dexamethasone (Decadron), cortisone acetate (Cortone), methylprednisolone acetate (Depo-Medrol), COX-2 selective inhibitors (that is, celecoxib (Celebrex) synthetic prostaglandins (for example, diclofenac sodium-misoprostol (Arthrotec) and misoprostol (Apo-Misoprostol) often used with nonsteroidal anti-inflammatory drugs). Approximately 31% of all SCI patients received at least one drug from this class of treatments. Interestingly, a clearly greater proportion of NTSCI patient (42% of this group) compared with TSCI patients (23% of this group) received these drugs (Table 19).

Discussion

This study is the first to describe an extensive list of drugs generally administered to SCI patients. More than 19 classes of compounds including more than 300 drugs were identified. Drug treatments against bowel and bladder problems, blood clot and deep vein thrombosis (DVT), cardiovascular problems, depression/anxiety, stomach acidity, infections, inflammation, sleep problems, pain and vitamin deficiency were clearly among the most commonly used classes of

compounds (between 35 and 66% of all SCI patients). Other pharmacological classes (that is, against bone loss, anemia, dyslipidemia, diabetes, respiratory problems, dermatosis or thyroid problems) were also significantly used (that is, between 10 and 20% of all SCI patients). However, we found absolutely no medication given specifically for muscle atrophy or hormonal dysregulation, which are also well-known secondary complications generally found in chronic SCI patients (see companion article no. 1).¹ Reasons for this remain unclear but may include incomplete medical records (for example, specific classes of drugs may not have been systematically reported in the records) or institution-based beliefs that some of the secondary complications should not be treated. Also, for some specific problems, such as anemia, that are generally recognized to be found in the acute hospitalization or early chronic phase (companion article no. 2)²⁻⁵ pharmacological data may have been lacking in the rehabilitation-based medical records (normally covering the period between early chronic and late chronic phases). This said, drugs against coagulation (34% of all patients) were more extensively used than iron supplements (12% of all patients) although DVT is also generally found soon after trauma. However, in contrast with anemia, which is generally mild in SCI patients, DVT is a serious vascular complication that significantly increases the risks of pulmonary embolisms.⁶ Unfortunately, the incidence of pulmonary embolisms caused by DVT has been shown

to remain elevated in SCI patients despite prophylactic approaches,⁷⁻⁹ which is probably why medication was commonly used as shown in this study.

Dyslipidemia is generally known to occur progressively in TSCI patients. For instance, we found in the companion article no. 2 that abnormal lipid levels (that is, high triglyceride, total cholesterol, low-density lipoprotein cholesterol) tend to be worst in NTSCI patients (for example, high total cholesterol even in late chronic NTSCI patients and higher LDL in late NTSCI patients compared with late TSCI ones). Accordingly, the results showed that drugs such as atorvastatin calcium were indeed commonly administered to NTSCI (22% of the group) and to a lesser extent to TSCI patients (12% of the group).

Regarding drugs against bone loss, it was rather surprising to find that a significant, but yet, a rather small proportion of patients (13% on average) were given bisphosphonates. Indeed, osteopenia and osteoporosis are generally considered to be widely found among chronic SCI patients (studied essentially in TSCI patients) as it has been reported that nearly all complete SCI individuals experience a significant loss of bone mineral tissue (up to 30% in the femora) leading to a marked increase of fracture incidence within 1 year after injury.¹⁰⁻¹⁴ Consequently, we did not expect only 13% of the patients to receive bisphosphonates as a much greater proportion should have been experiencing extensive bone loss. Unfortunately, dual-energy X-ray absorptiometry data were not available in the records studied. In addition, our study results showed clearly that more NTSCI patients (20% of this group) compared with TSCI patients (7% of the TSCI group) were given bisphosphonates, strongly suggesting that bone loss was probably more common (or to a greater level) in NTSCI than TSCI patients.

It was also particularly surprising to find that bronchodilators were more commonly given to NTSCI (20.2% of them) than TSCI (8.5% of them) patients. Indeed, to the best of our knowledge, pulmonary problems have been essentially studied in TSCI patients although our study results strongly support the idea that pulmonary problems are greater (or more commonly found) in NTSCI patients. However, the opposite trend was found with antidepressant and anxiolytic drugs that were found, here, to be mainly given to TSCI patients (50.0% of this group) and to a lesser extent to NTSCI individuals (24.6% of the NTSCIs).

Infections and pain (either chronic or mild) are typically found in SCI patients.¹⁵⁻¹⁷ Here, the results showed that almost as many patients from both groups TSCI and NTSCI were found to use these classes of treatments. These drugs were clearly found to be among the most commonly used classes of drugs in SCI patients (for example, drugs against infections were used by 75% of the complete SCI patients).

All and all, a wide variety of drugs were found to be prescribed to SCI patients. Moreover, additional drugs (not listed in the Results section) were also found, although only occasionally, to be given to these patients such as tadalafil (Cialis), sildenafil citrate (Viagra), conjugated estrogens (Premarin), naratriptan HCl (Amerge), sumatriptan (Imitrex), gout therapy (Colchicine), allopurinol (Zyloprim), botulinum toxin type A (Botox), ondansetron (Zofran),

betahistine dihydrochloride (Serc), barbiturates (Phenobarbital), zopiclone (Rohovane), methylphenidate HCl (Ritalin), cyproheptadine HCl (Periactin), probacalac (Bifilact), hydrocortisone acetate-zinc sulfate (Anusol-HC), benzoylperoxide (Benzogel), calcium carbonate (Tums) and so on.

Conclusion

This study strongly supports the idea that different pharmacological approaches are occasionally used for TSCI and NTSCI patients. Although, some classes of drugs expected to be used by SCI patients were not given to these patients (for example, hormonal replacement therapy), an unexpectedly large number of classes and drugs were nonetheless routinely prescribed to both groups of patients (with some between-group differences). Recommendations should be made by experts to carefully examine either the necessity or the effectiveness of each treatment as well as the possibility of developing alternative strategies based on physical activity, nutrition and lifestyle.

Conflict of interest

The authors declare no conflict of interest.

Acknowledgements

We thank the Interval Rehabilitation Center for its collaboration and devoted work in retrieving the corresponding medical files and, occasionally, some missing information. We acknowledge the support from Nordic Life Science Pipeline and NeuroSpina Therapeutics for this 3-year study.

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