Volume 38, Issue 1 (January, 2015), pp. 84-90

< Prev Next >

Medical complications and falls in patients with spinal cord injury during the immediate phase after completing a rehabilitation program

Jirabhorn Wannapakhe[1,2]; Preeda Arrayawichanon[2,3]; Jiamjit Saengsuwan[2,4]; Sugalya Amatachaya[1,2]
Author Affiliations

Keywords: Complication, Fall, Paraplegia, Rehabilitation, Tetraplegia
DOI: http://dx.doi.org/10.1179/2045772313Y.0000000173

Abstract

Background/objectives

Complications and falls are crucial problems in patients with spinal cord injury (SCI). However, existing evidence on complications comes from data from hospital records over a long period of time, and falls were mostly reported retrospectively in patients with incomplete SCI. This study prospectively explored the occurrence of complications and falls, and associated factors in patients with SCI during the 6 months after discharge.

Methods

One hundred subjects with SCI (50 wheelchair-bound (WB) and 50 ambulatory (AM) subjects) from a tertiary rehabilitation center completed the study. Every month, subjects were monitored for data on medical complications and falls. Descriptive information is provided for each group.

Results

Every WB subject had complications and 14 subjects were re-hospitalized. The most frequent complications found in these subjects were neurogenic pain (36 subjects), urinary tract infection (UTI) (25 subjects), and pressure ulcers (21 subjects). In AM subjects, 38 subjects (76%) experienced complications and 3 subjects needed re-hospitalization. The most frequent complications included neurogenic pain (35 subjects) and UTI (11 subjects). Eighteen WB subjects (36%) and 27 AM subjects (54%) experienced falls. WB subjects had significantly increased odds for incidence of UTI and pressure ulcers, whereas AM subjects had significantly greater odds for falls ($P < 0.05$).

Conclusion

A number of subjects with SCI experienced complications and falls after completing a rehabilitation program. The findings add to our knowledge about complications and falls after SCI, and confirm the importance of effective strategies to minimize the occurrence of complications and falls in these individuals.

Keywords: Complication, Fall, Paraplegia, Rehabilitation, Tetraplegia

Print ISSN: 1079-0268
Online ISSN: 2045-7723

Published on behalf of the
Academy of Spinal Cord Injury Professionals (ASCIP)

"*We are pleased to welcome Dr. Hwang to the ranks of Bors Award honorees*," said Donald Bodner, MD, editor of *JSCM*. "*We anticipate that this is just the first acknowledgment of her dedication to spinal cord injury care and research*."

Read the press release >

The latest advances in technology for people with spinal cord injury

A special issue of *The Journal of Spinal Cord Medicine* examines various advances made in technology to aid people with spinal cord injury. Scientists from all over the world contributed to the special issue, focusing on five areas: advances in wheelchair technology; wheelchair sports; personal health and safety; innovations in rehabilitation; and closing the gaps in education and employment.

The issue is guest edited by Dr Rory Cooper, Engineering Director of the University of Pittsburgh SCI Model System. His commentary, 'Technology, trends, and the future for people with spinal cord injury' is available for free download.

Get TOC alerts | Join subject mailing list

Most read | Most cited

The most frequently downloaded articles from *The Journal of Spinal Cord Medicine* in the past month.

Spinal Cord Injury Facts and Figures at a Glance

International standards for neurological classification of spinal cord injury (Revised 2011)
Kirshblum et al.

Bone loss and fractures in limbs paralyzed by spinal cord injury: Prevention, diagnosis, and treatment
Ragnarsson

Technology, trends, and the future for people with spinal cord injury
Cooper

The application of implementation science for pressure ulcer prevention best practices in an inpatient spinal cord injury rehabilitation program
Scovil et al.

See more >

Research article

Medical complications and falls in patients with spinal cord injury during the immediate phase after completing a rehabilitation program

Jirabhorn Wannapakhe[1,2], Preeda Arrayawichanon[2,3], Jiamjit Saengsuwan[2,4], Sugalya Amatachaya[1,2,5]

[1]School of Physical Therapy, Faculty of Associated Medical Sciences, Khon Kaen University, Khon Kaen, Thailand, [2]Improvement of Physical Performance and Quality of Life (IPQ) Research Group, Khon Kaen University, Khon Kaen, Thailand, [3]Department of Rehabilitation Medicine, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand, [4]Faculty of Public Health, Khon Kaen University, Khon Kaen, Thailand, [5]Back, Neck and Other Joint Pain (BNOJP) Research Group, Khon Kaen University, Khon Kaen, Thailand

Background/objectives: Complications and falls are crucial problems in patients with spinal cord injury (SCI). However, existing evidence on complications comes from data from hospital records over a long period of time, and falls were mostly reported retrospectively in patients with incomplete SCI. This study prospectively explored the occurrence of complications and falls, and associated factors in patients with SCI during the 6 months after discharge.

Methods: One hundred subjects with SCI (50 wheelchair-bound (WB) and 50 ambulatory (AM) subjects) from a tertiary rehabilitation center completed the study. Every month, subjects were monitored for data on medical complications and falls. Descriptive information is provided for each group.

Results: Every WB subject had complications and 14 subjects were re-hospitalized. The most frequent complications found in these subjects were neurogenic pain (36 subjects), urinary tract infection (UTI, 25 subjects), and pressure ulcers (21 subjects). In AM subjects, 38 subjects (76%) experienced complications and 3 subjects needed re-hospitalization. The most frequent complications included neurogenic pain (35 subjects) and UTI (11 subjects). Eighteen WB subjects (36%) and 27 AM subjects (54%) experienced falls. WB subjects had significantly increased odds for incidence of UTI and pressure ulcers, whereas AM subjects had significantly greater odds for falls ($P < 0.05$).

Conclusion: A number of subjects with SCI experienced complications and falls after completing a rehabilitation program. The findings add to our knowledge about complications and falls after SCI, and confirm the importance of effective strategies to minimize the occurrence of complications and falls in these individuals.

Keywords: Complication, Fall, Paraplegia, Rehabilitation, Tetraplegia

Introduction

Spinal cord injury (SCI) affects normal functions of the motor, sensory, and autonomic systems and this limits the ability of SCI patients to perform daily activities.[1] Although patients show functional improvement after participation in a rehabilitation program, this improvement does not continue after discharge.[1,2] In addition, a trend toward decreased length of stay in a hospital (from 115 days in 1974 to 36 days in 2005)[3,4] may affect the ability of the patients at the time of discharge. Thereafter, lack of home adaptation and mobility devices may increase the chance of a hypoactive lifestyle that further retards functional improvement of the patients.[1]

Many studies have reported that patients with SCI encounter a high risk of medical complications and falls.[3,5–11] Previous studies have found that anywhere

Correspondence to: Sugalya Amatachaya, School of Physical Therapy, Faculty of Associated Medical Sciences, Khon Kaen University, Khon Kaen 40002, Thailand. Email: samata@kku.ac.th

DOI 10.1179/2045772313Y.0000000173

from 15 to 100% of subjects with SCI experience medical complications.[5,8,11] However, the data were gathered retrospectively over a long period of time (1–20 years) using subjective reports or medical records.[8,11] The findings may be influenced by many factors such as incomplete records, loss of structured training, and reduction of guidance or peer-control in self-care, that decreases conscious awareness about preventive methods such as skin care and bladder management. A prospective study,[5] however, recruited only 21 subjects with complete SCI and 23 subjects with incomplete SCI, which might reduce the strength of the findings. For the falls, the data were mostly reported for patients with incomplete SCI using retrospective data collection over 6–12 months using mail survey or face-to-face interview. This could increase the chance of recall bias and selective attrition/response between responders and non-responders on the findings.[12,13] Recently, Phonthee *et al.*[10] prospectively reported fall data in 89 community dwelling subjects with incomplete SCI, and found that 39% of the subjects experienced at least one fall over 6 months. Amatachaya *et al.*[5] prospectively investigated fall data in 44 subjects with complete and incomplete SCI, and found that 33% of subjects with complete SCI and 74% of those with incomplete SCI fell during 6 months after discharge. Interestingly, these studies found that subjects who fell encountered serious consequences, i.e. fractures, after falls. To ensure the occurrence of medical complications and falls after completion of a rehabilitation program, this study prospectively explored the incidence and consequences of complications and falls, and associated factors in patients with complete and incomplete SCI over 6 months after discharge. The findings would add important information to the existing literature related to medical complications and falls in these individuals.

Methods

Subjects and setting

The researchers recruited 100 subjects with SCI (50 wheelchair-bound (WB) and 50 ambulatory (AM) subjects) who were consecutively admitted to a tertiary rehabilitation center in Thailand from June 2010 to April 2012. The eligible subjects were at least 18 years of age and suffered from SCI due to traumatic causes or non-progressive diseases at a sub-acute (post-injury time: PIT < 12 months) or chronic (PIT ≥ 12 months) stage of injury. The WB subjects were those with the American Spinal Injury Association (ASIA) Impairment Scale (AIS) A and B.[14] The AM subjects refer to those who are able to walk independently over at least 10 m with or without a walking device. Patients were excluded if they presented signs and symptoms that might affect the findings, such as deformity in the joints of the lower extremities, leg length discrepancy, and brain function disorders. All subjects provided a written informed consent document approved by the Khon Kaen University Ethics Committee in Human Research prior to participation in the study.

Procedure

During the 2–3 days prior to discharge, the eligible subjects were interviewed and assessed for their baseline data, including age, sex, and stage, level and severity of SCI using the criteria of the American Spinal Injury Association.[15] Then, the incidence and consequences of complications and falls were gathered monthly for 6 months via telephone interview. For the accuracy of data collection, specific definitions and criteria were established including

- Fall: an unplanned, unexpected, unintentional event that resulted in a person coming to rest on the ground, other lower level or supporting surface.[5,6,10,16]
- Medical complications: the study monitored the occurrence of medical complications that were frequently reported in the literature in which the determinants of terminologies for the complications are as follows:
  - Pressure ulcer: an area of injury to skin or underlying soft tissue due to excessive or prolonged pressure that induces redness or ulcers to the skin areas.[17]
  - Neurogenic pain: a sign of numbness, itching, tingling, coldness, warmth, perspiration, girdle zone pain and phantom feelings at and/or below the level of the lesion.[11]
  - Decreased range of motion (ROM): limitation of ROM due to shortening or contracture of connective tissues, joint capsules, muscles, and tendons around the joints.[17]
  - Musculoskeletal pain: nociceptive pain originating from bones, joints or muscles following trauma or overuse.[11]
  - Autonomic dysreflexia: a sympathomimetic response to a stimulus below the level of SCI and marked by symptoms such as hypertension, sweating above the level of the lesion, nasal stuffiness, or headache requiring an intervention other than sitting the person up to decrease hypertension.[8]
  - Respiratory complications including signs of slow and abnormal breathing, and dyspnea.[17]

In addition, data on other complications such as heterotopic ossification, osteoporosis, fracture, renal calculi, urinary tract infection (UTI), and deep vein thrombosis were collected with confirmation by a physician or medical record. However, the study did not consider

spasticity as a medical complication because it was a direct neurological consequence of SCI.[11] The occurrence of each complication or fall was recorded as yes or no, and if yes, the consequences of the complications and falls were also gathered. With regard to complications, if subjects reported the continuity of the abnormalities over a period of time, it was counted as one complication.

Statistical analyses

The descriptive statistics were applied to explain baseline demographics, SCI characteristics and findings of the WB and AM subjects. The multiple logistic regression analysis was used to analyze the association between baseline demographics (including age and gender), SCI characteristics (including cause, stage, and level of SCI), and levels of ability of the subjects, and the occurrence of complications and falls. The level of significant difference was set at $P < 0.05$.

Results

One hundred and eight patients with SCI agreed to participate in the study. However, eight patients were excluded due to the reasons shown in Fig. 1. Therefore, 100 subjects completed the study and most of them were males at a chronic stage of injury (Table 1). Details of medical complications and falls are given below.

Medical complications: incidence, consequences, and associated factors

All WB subjects (100%) experienced at least one medical complication during 6 months after discharge (Fig. 1). Among these, 32 subjects (64%) had at least two complications (range 2–5 times/subject in which 26 subjects had two complications, 5 subjects had three complications, and 1 subject had four complications). Table 2 demonstrates the types of complications found in the study and the rate of rehospitalization due to having a complication. The most frequent complications found in WB subjects were UTI (25 subjects, range 1–4 times/subject), neurogenic pain (36 subjects, range 1–2 times/subject), and pressure ulcers (21 subjects, range 1–4 times/subject), and 15 subjects had to be readmitted for 3–60 days (Table 2).

Among the AM subjects, 38 (76%) had medical complications (Fig. 1). Of these, 18 subjects (36%) had at least two complications (range 2–4 times/subject in

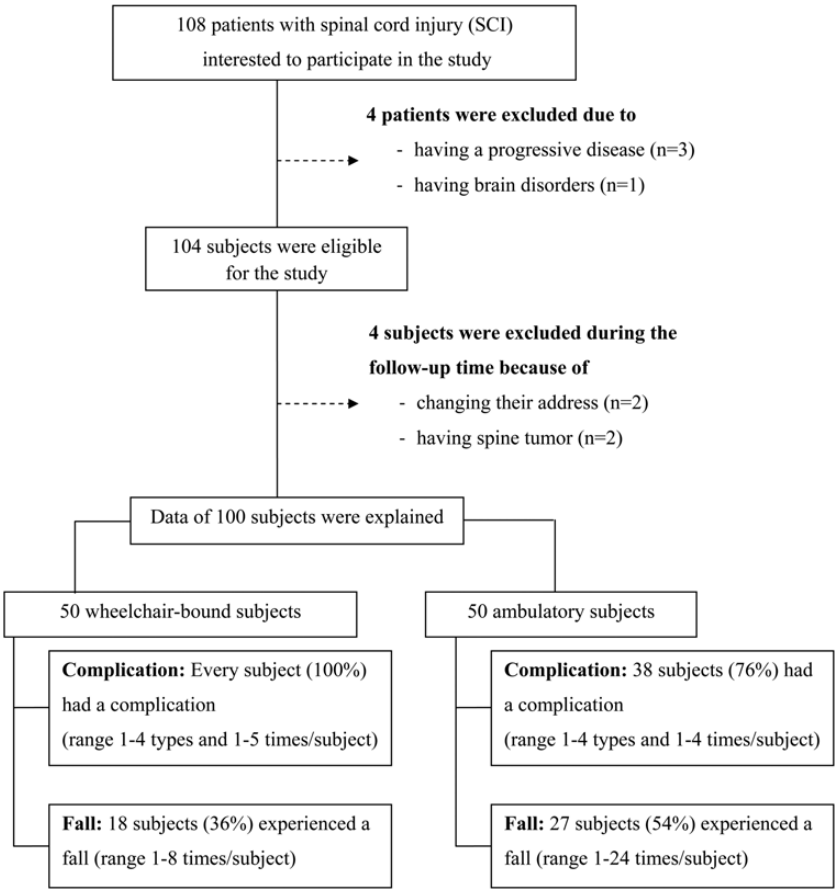

Figure 1 Subject participation flow chart.

Table 1 Baseline demographics and spinal cord injury characteristics of the subjects

Variable	Wheelchair-bound subjects ($n = 50$)	Ambulatory subjects ($n = 50$)	*P* value
Age (years)*	42.12 ± 12.25	48.00 ± 13.96	0.027‡
Post injury time (months)*	69.00 ± 73.63	38.38 ± 41.22	0.015‡
Sex: male (*n* (%))†	43 (86)	38 (76)	0.20
Cause of injury: traumatic (*n* (%))†	32 (64)	21 (42)	0.03‡
Stage of injury: chronic (*n* (%))†	44 (88)	37 (74)	0.07
Level of injury: paraplegia (*n* (%))†	30 (60)	30 (60)	1.00

*The data are presented using mean ± SD.
†These variables were categorized according to the following criteria: sex: male/female, cause of injury: traumatic/non-progressive disease, stage of injury: chronic/subacute, level of injury: paraplegia/tetraplegia.
‡Indicates significant differences.

Table 2 Incidence of medical complications and rate of re-hospitalization of the subjects during 6 months

	WB subjects ($n = 50$)		AM subjects ($n = 38$)	
Types of complications	Incidence of complications (*n* (range*))	Re-hospitalization (*n* (days))	Incidence of complications (*n* (range*))	Rehospitalization (*n* (days))
Neurogenic pain	36 (1–2)	–	35 (1–2)	–
Urinary tract infection	25 (1–4)	11 (3–30)	11 (1–3)	2 (10)
Pressure ulcer	21 (1–4)	4 (14–60)	3 (1)	–
Muscular pain	2 (1)	–	3 (1–2)	–
Decreased ROM	2 (1)	–	3 (1)	–
Renal calculi	2 (1)	1 (30)	1 (1)	1 (3)
Respiratory complication	1 (1)	–	5 (1)	–
Autonomic dysreflexia	1 (1)	–	3 (1)	–
Heterotopic ossification	0	–	1 (1)	–

Note: *The data are presented in time(s)/subjects. Each wheelchair-bounded (WB) and ambulatory (AM) subject experienced 1–4 complications.
n, number of subjects; ROM, range of motion.

which 10 subjects had two complications, 7 subjects had three complications, and 1 subject had four complications). The common complications reported in these subjects were neurogenic pain (35 subjects, range 1–2 times/subject) and UTI (11 subjects, range 1–3 times/subject) in which three subjects needed re-hospitalization for 3–10 days (Table 2). Being a WB subject was significantly associated with incidence of UTI and pressure ulcers as compared with being an AM subject ($P < 0.05$, Table 3).

Table 3 Data on factors associated with the occurrence of common medication complications and falls

	Medical complications							
	Urinary tract infection		Neurogenic pain		Pressure ulcer		Falls	
Variable	aOR (95% CI)	*P* value	aOR (95% CI)	*P* value	aOR (95% CI)	*P* value	aOR (95% CI)	*P*-value
Age	2.82 (0.98–8.09)	0.06	1.32 (0.51–3.42)	0.57	0.61 (0.20–1.91)	0.40	1.91 (0.74–4.93)	0.18
Sex	1.40 (0.38–5.18)	0.61	0.85 (0.25–2.89)	0.80	1.07 (0.22–5.17)	0.93	1.65 (0.50–5.40)	0.41
Cause of injury	0.88 (0.31–2.49)	0.81	1.23 (0.45–3.32)	0.69	1.01 (0.31–3.35)	0.99	2.59 (0.97–6.92)	0.06
Stage of injury	3.79 (0.93–15.54)	0.06	0.80 (0.25–2.57)	0.71	1.09 (0.23–5.09)	0.91	1.29 (0.42–3.97)	0.65
Level of injury	0.59 (0.23–1.51)	0.27	1.48 (0.60–3.63)	0.86	2.32 (0.76–7.07)	0.14	1.89 (0.77–4.65)	0.17
Level of ability	3.85 (1.49–9.94)	0.01*	1.05 (0.43–2.57)	0.92	10.99 (2.87–42.16)	0.00*	0.37 (0.15–0.89)	0.03*

Each factor is categorized as follows: age: age <40 years (reference group)/age ≥40, sex: female (reference group)/male, cause of injury: non-progressive diseases (reference group)/traumatic, stage of injury: sub-acute (reference group)/chronic, level of injury: tetraplegia (reference group)/paraplegia, level of ability: ambulatory (reference group)/wheelchair-bound.
aOR, adjusted odd ratio; 95% CI, 95% confidence interval.
*aOR is significantly different from the reference group for which the value was set at 1.0 ($P < 0.05$).

Table 4 Falls data of the subjects

Fall data	Number of falls* (*n* (%))	
	WB subjects	AM subjects
Location of falls		
Within the house	20 (53)	55 (63)
Around the house	18 (47)	21 (24)
Community	–	10 (12)
Workplace	–	1 (1)
Activity during fall		
Performing activities in a wheelchair	35 (92)	–
Wheelchair transfer	1 (3)	–
Performing activities in a chair or bed	2 (5)	–
Walking	–	87 (100)
Factors inducing falls as perceived by the subjects		
Lower limb muscle weakness	1 (3)	10 (12)
Loss of balance	4 (11)	33 (38)
Environmental hazards	29 (77)	33 (38)
Increased spasticity	1 (3)	9 (10)
Less attention during movement	2 (6)	2 (2)
Consequences of fall		
Physical consequences		
Bruise or skin abrasion	4 (10)	22 (25)
Muscle pain or tear	–	1 (1)
Unconsciousness	1 (3)	1 (1)
None	33 (87)	63 (72)
Psychological consequences		
Fear of fall	–	1 (1)
None	38 (100)	86 (99)
Functional consequences		
Reduced mobility and social communication	–	6 (7)
None	38 (100)	81 (93)

*The total number of fall in WB subjects was 38 and in AM subjects was 87.

Falls: incidence, consequences, and associated factors

During 6 months after discharge, falls occurred in 18 WB subjects (36%, range 1–8 times) and 27 AM subjects (54%, range 1–24 times) (Fig. 1). In WB subjects, the falls mostly occurred while they were performing an activity in a wheelchair within and around the house, and of these four subjects had bruises and another subject became unconscious after the fall (Table 4). For AM subjects, the falls occurred while they were walking inside the house due to loss of balance and a hazardous environment. After falls, 13 subjects had physical consequences, in which 12 subjects reported bruises and muscular pain and 1 subject became unconscious after the fall. Among these, six subjects required medical attention and the other six subjects reported functional and psychological consequences such as prolonged bed rest, reduced mobility, reduced social communication, and increased level of fear of falls (Table 4). The multiple logistic regression analysis demonstrated that being an AM subject significantly increased the odds of experiencing a fall by 2.74 times of WB subjects ($P < 0.05$, Table 3).

Discussion

To the researchers' knowledge, this is the first study that reports the occurrence of complications and falls during 6 months after completing a rehabilitation program separately for WB and AM subjects with SCI. The data demonstrated that all WB subjects (100%) experienced medical complications, particularly UTI, pressure ulcers, and neurogenic pain, which led to an increased rate of hospitalization. In addition, most AM subjects (76%) had medical complications in which the common complications found were neurogenic pain and UTI (Table 2). For the falls, 36% of WB subjects and 54% of AM subjects experienced at least 1 fall in 6 months. WB subjects had significantly increased odds for UTI and pressure ulcers, whereas AM subjects had significantly higher odds for falls by 2.74 times that of WB subjects ($P < 0.05$, Table 3).

The findings were coherent with previous reports that subjects with SCI had a high rate of medical complications.[3,8,11] Amatachaya *et al.*[5] prospectively collected the data and found that every subject with motor complete SCI and 82% of those with motor incomplete SCI experienced medical complications during the 6 months follow-up. However, the study recruited only

44 subjects (21 subjects with motor complete and 23 subjects with motor incomplete SCI) which may limit the applicability of the findings. Haisma *et al.*[11] found that UTI and pressure ulcers were the most common complications in WB subjects. McKinley *et al.*[8] found that pressure ulcers and abnormal renal tests were common complications after 20 years post SCI. The researchers suggested that the frequent complications might relate to a high demand in daily life, and the reduction of structured training and feedback that decreased conscientiousness toward preventive measures.[11] The findings of this prospective study confirmed that, even in the immediate phase after completing a rehabilitation program, subjects with SCI also encountered a high risk of medical complications, particularly WB subjects (Table 2). The lesions in these subjects severely disrupted the integration of the motor, sensory, and autonomic functions from below the level of the lesion, and obviously decreased functional ability and inevitably associated with an increased risk of complications.[1,18–21] Medical complications are a frequent cause of morbidity and mortality, and lead to an increased rate of hospitalization, increased care cost, loss of employability, and decreased quality of life.[3,8] Cardenas *et al.*[3] have indicated that the occurrence of medical complications plays an important role in the continuum of care for individuals with SCI. The researchers also found that subjects with SCI who were discharged with lower motor functional independence measure (FIM) scores had a greater likelihood of re-hospitalization. Haisma *et al.*[11] also reported factors inducing the risk of complications in subjects with SCI including age, body mass index, traumatic lesion, tetraplegia, and complete lesion. Furthermore, the occurrence of medical complications and reduction of functional ability following SCI introduced negative impacts on psychological status that is commonly associated with neurogenic pain, quality of life, and physical functions of these individuals.[5,8,22] Many studies have also reported factors influencing the occurrence of UTI and pressure ulcers, including the lack or reduction of personal hygiene, daily change of condom catheter, moisture management, sheering force, and continuous pressure to the skin area.[3,8,23–26] Findings of the current study suggested that UTI was a leading cause of re-hospitalization for the subjects (Table 2). Eastwood *et al.*[14] also found that lower FIM scores at discharge, the level of the lesion and use of an indwelling catheter at discharge increased rate of re-hospitalization in subjects with SCI. Therefore, rehabilitation professionals should keep these factors in mind when giving recommendations to these patients.

In addition, a number of WB and AM subjects reported falls after discharge (Fig. 1). Previous studies reported the incidence of falls in AM subjects with SCI ranging between 34 and 75%.[5,6,9,10] The researchers suggested that good functional ability may afford confidence to the subjects while moving. However, the sensorimotor deterioration following SCI might distort their ability to move safely, and thus they encountered a high risk of falls.[10] Nonetheless, most of these data were taken retrospectively from AM subjects with SCI. To the researchers' knowledge, there were only two studies[5,10] that prospectively monitored fall data in subjects with SCI. For WB subjects, the findings of this study were associated with those of Amatachaya *et al.*[5] who found that seven subjects with motor complete SCI (33%) fell at least once in 6 months. For AM subjects, the findings were higher than those of Phonthee *et al.* (39%)[10] who monitored weekly for the fall data in community-dwelling AM subjects with SCI during 6 months. The researchers suggest that frequent prospective monitoring of fall data may lead to the "Howthorne effect," that likely happens when individuals realize that they are being observed and temporarily increase attention during movements, which affects incidence of falls of the subjects.[10] A higher number of falls in AM subjects, as compared with WB subjects, confirm the assumption of previous studies[5,9] that increased level of mobility exposes subjects with SCI to fall opportunities. Similarly, Simpson *et al.*[27] also found that increased levels of functional ability in subjects with stroke as measured using the Timed Up and Go test enhanced the risk of falls of the subjects.

The findings of this study add information on medical complications and falls to the body of existing evidence in subjects with SCI. Despite the improvement in medical care and life expectancy in patients with SCI, the incidence of complications and falls remains high even in the immediate period after completing a rehabilitation program. Although the data were subjectively reported by the subjects and their relatives, the researchers attempted to minimize errors of the findings by interviewing for related data and checking with information from medical records, if available. Nevertheless, the data were reported for only WB (AIS A and B) and AM subjects, but did not cover individuals with some motor recovery. This may limit the utility of the findings. Moreover, the data of age, post-injury time, and cause of injury were significantly different between the groups (Table 1), and these differences might confound the association between being WB or AM subjects and the occurrence of complications and falls. However, the multiple logistic regression analysis showed no

significant correlation between these factors and the major outcomes of the study (Table 3). Furthermore, the findings of the study did not directly suggest strategies to reduce medical complications and falls in individuals with SCI. A further study on the exploration for an effective intervention to minimize the occurrence of complications and falls in these individuals, particularly when faced with their own environments, is needed.

Conclusions

A number of WB and AM subjects with SCI experienced medical complications and falls that increased rates of re-hospitalization, even in the immediate phase after being fully involved with a rehabilitation program. Therefore, apart from improvement of physical ability, a strategy to prevent or reduce the occurrence of complications and falls is crucial to promote the effectiveness of a rehabilitation program.

Acknowledgments

This study was supported by funding from the KKU-Integrated Multidisciplinary Research Cluster, the Postgraduate School, Faculty of Associated Medical Sciences, and the Improvement of Physical Performance and Quality of life (IPQ) research groups, Khon Kaen University. The researchers thank Mr Ian Thomas for his contribution in preparing this manuscript.

References

1 van den Berg-Emons RJ, Bussmann JB, Haisma JA, *et al.* A prospective study on physical activity levels after spinal cord injury during inpatient rehabilitation and the year after discharge. Arch Phys Med Rehabil 2008;89(11):2094–101
2 Wirth B, van Hedel H, Kometer B, Dietz V, Curt A. Changes in activity after a complete spinal cord injury as measured by the spinal cord independence measure II (SCIM II). Neurorehabil Neural Repair 2008;22(2):145–53.
3 Cardenas DD, Hoffman JM, Kirshblum S, McKinley W. Etiology and incidence of rehospitalization after traumatic spinal cord injury: a multicenter analysis. Arch Phys Med Rehabil 2004; 85(11):1757–63.
4 Ronen J, Itzkovich M, Bluvshtein V, Thaleisnik M, Goldin D, Gelernter I, *et al.* Length of stay in hospital following spinal cord lesions in Israel. Spinal Cord 2004;42(6):353–8.
5 Amatachaya S, Wannapakhe J, Arrayawichanon P, Siritarathiwat W, Wattanapun P. Functional abilities, incidences of complications and falls of patients with spinal cord injury 6 months after discharge. Spinal Cord 2011;49(4):520–4.
6 Brotherton SS, Krause JS, Nietert PJ. A pilot study of factors associated with falls in individuals with incomplete spinal cord injury. J Spinal Cord Med 2007;30(3):243–50.
7 Krause JS. Factors associated with risk for subsequent injuries after traumatic spinal cord injury. Arch Phys Med Rehabil 2004; 85(9):1503–8.
8 McKinley W, Jackson AB, Cardenas DD, DeVivo MJ. Long-term medical complications after traumatic spinal cord injury: a regional model systems analysis. Arch Phys Med Rehabil 1999; 80(11):1402–10.
9 Phonthee S, Saengsuwan J, Amatachaya S. Falls in independent ambulatory patients with spinal cord injury: incidence, associated factors and levels of ability. Spinal Cord 2013;51(5):365–8.
10 Phonthee S, Saengsuwan J, Siritaratiwat W, Amatachaya S. Incidence and factors associated with falls in independent ambulatory individuals with spinal cord injury: a 6-month prospective study. Phys Ther 2013;93(8):1061–72.
11 Haisma JA, van der Woude LH, Stam HJ, Bergen MP, Sluis TA, Post MW, *et al.* Complications following spinal cord injury: occurrence and risk factors in a longitudinal study during and after inpatient rehabilitation. J Rehabil Med 2007;39(5):393–8.
12 Bradburn NM, Rips LJ, Shevell SK. Answering autobiographical questions: the impact of memory and inference on surveys. Science 1987;236(4798):157–61.
13 Hassan E. Recall bias can be a threat to restrospective and prospective research designs. Internet J Epidemiol 2006;3(2):1–8.
14 Eastwood EA, Hagglund KJ, Ragnarsson KT, Gordon WA, Marino RJ. Medical rehabilitation length of stay and outcomes for persons with traumatic spinal cord injury-1990–1997. Arch Phys Med Rehabil 1999;80(11):1457–63.
15 Kirshblum SC, Burns SP, Biering-Sorensen F, Donovan W, Graves DE, Jha A, *et al.* International standards for neurological classification of spinal cord injury (revised 2011). J Spinal Cord Med 2011;34(6):535–46.
16 Brotherton SS, Krause JS, Nietert PJ. Falls in individuals with incomplete spinal cord injury. Spinal Cord 2007;45(1):37–40.
17 Blackwell TL, Krause JS, Winkler T, Stiens SA. Spinal cord injury desk reference: guidelines for life care planning and case management. New York: Demos Medical Publishing; 2001. p. 193–211.
18 Haisma JA, Bussmann JB, Stam HJ, Sluis TA, Bergen MP, Dallmeijer AJ, *et al.* Changes in physical capacity during and after inpatient rehabilitation in subjects with a spinal cord injury. Arch Phys Med Rehabil 2006;87(6):741–8.
19 Haisma JA, Van der Woude LH, Stam HJ, Bergen MP, Sluis TA, de Groot S, *et al.* Prognostic models for physical capacity at discharge and 1 year postdischarge from rehabilitation in persons with spinal cord injury. Arch Phys Med Rehabil 2007;88(12): 1694–703.
20 Maynard FM, Bracken MB, Creasey G, Ditunno JF Jr, Donovan WH, Ducker TB, *et al.* International standards for neurological and functional classification of spinal cord injury. American Spinal Injury Association. Spinal Cord 1997;35(5):266–74.
21 New PW. Functional outcomes and disability after nontraumatic spinal cord injury rehabilitation: results from a retrospective study. Arch Phys Med Rehabil 2005;86(2):250–61.
22 Barrett H, McClelland JM, Rutkowski SB, Siddall PJ. Pain characteristics in patients admitted to hospital with complications after spinal cord injury. Arch Phys Med Rehabil 2003;84(6):789–95.
23 Cardenas DD, Hooton TM. Urinary tract infection in persons with spinal cord injury. Arch Phys Med Rehabil 1995;76(3): 272–80.
24 Culleres GR, Sugranes JC, Planells Romeo I, Gimenez Perez M. Characteristics of urinary tract infections in different patient subpopulations and depending on the bladder emptying system. Actas Urol Esp 2010;34(3):251–7.
25 Liguori PA, Cardenas DD, Ullrich P. Social and functional variables associated with urinary tract infections in persons with spinal cord injury. Arch Phys Med Rehabil 1997;78(2):156–60.
26 New PW, Rawicki HB, Bailey MJ. Nontraumatic spinal cord injury rehabilitation: pressure ulcer patterns, prediction, and impact. Arch Phys Med Rehabil 2004;85(1):87–93.
27 Simpson LA, Miller WC, Eng JJ. Effect of stroke on fall rate, location and predictors: a prospective comparison of older adults with and without stroke. PLoS One 2011;6(4):1–6.

Authors Queries

Journal: **The Journal of Spinal Cord Medicine**
Paper: **JSCM-D-13-00057**
Article title: **Medical complications and falls in patients with spinal cord injury during the immediate phase after completing a rehabilitation program**

Dear Author
During the preparation of your manuscript for publication, the questions listed below have arisen.
Please attend to these matters and return this form with your proof. Many thanks for your assistance

Query Reference	Query	Remarks
1	Please list out the first six author names in ref. 1 as required by journal style.	