SSM -Population Health 2 (2016) 259–268

Contents lists available at ScienceDirect

SSM -Population Health

journal homepage: www.elsevier.com/locate/ssmph

Article

Inpatient migration patterns in persons with spinal cord injury: A registry study with hospital discharge data

Elias Ronca [a,b], Anke Scheel-Sailer [c], Hans Georg Koch [d], Stefan Metzger [c], Armin Gemperli [a,b,*]

[a] Swiss Paraplegic Research, Nottwil, Switzerland
[b] Department of Health Sciences and Health Policy, University of Lucerne, Lucerne, Switzerland
[c] Swiss Paraplegic Centre, Nottwil, Switzerland
[d] Swiss Paraplegics Association, Nottwil, Switzerland

ARTICLE INFO

Article history:
Received 8 October 2015
Received in revised form
8 April 2016
Accepted 8 April 2016

Keywords:
Spinal cord injury
Patient migration
Health services accessibility
Health care utilization
Inpatient hospital care

ABSTRACT

This study investigated and compared patient migration patterns of persons with spinal cord injury, the general population and persons with morbid obesity, rheumatic conditions and bowel disease, for secondary health conditions, across administrative boundaries in Switzerland. The effects of patient characteristics and health conditions on visiting hospitals outside the residential canton were examined using complete, nationwide, inpatient health records for the years 2010 and 2011. Patients with spinal cord injury were more likely to obtain treatment outside their residential canton as compared to all other conditions. Facilitators of patient migration in persons with spinal cord injury and the general hospital population were private or accidental health insurances covering costs. Barriers of patient migration in persons with spinal cord injury were old age, severe multimorbidity, financial coverage by basic health insurance, and minority language region.

1. Introduction

Persons with spinal cord injury (SCI) experience a higher prevalence of chronic health conditions (e.g. heart disease, stroke, diabetes) than the general population (Bauman & Spungen, 2008; Myers, Lee, & Kiratli, 2007; Wahman et al., 2010; Wu et al., 2012) and are at high risk of severe secondary conditions such as pneumonia, pressure ulcers or urinary tract infections (Cardenas, Hoffman, Kirshblum, & McKinley, 2004; Chiodo et al., 2007). They were found to consult medical specialists more often than the general population (Dryden et al., 2004), which was thought to lead to better management of the disease (Smith, 2002). Maintaining the long-term health status of persons with SCI requires ongoing access to both general and specialist services. Because of the nature of their condition, persons with SCI are likely to experience problems with access to needed services (Beatty et al., 2003; Kim, Nam, Hwang, & Shin, 2014).

The World Health Organization (WHO) has recognized the need to improve healthcare access for individuals with disabilities. The respective WHO Action Plan presumes a profound understanding of the barriers that individuals with disabilities face in regards to accessing healthcare services (World Health Organization, 2014). Hospital discharge data, which is readily available in many countries (OECD, 2015), can be used to study three dimensions of access to healthcare services defined by Penchansky and Thomas (Penchansky & Thomas, 1981). Those are (1) availability, (2) accessibility, and (3) affordability of services. Availability is the relationship of the volume and type of existing services to the clients' needs. Accessibility is the relationship between the location of supply and the location of clients and, affordability is the relationship of prices to the clients' income, and existing health insurance.

The European Spinal Cord Injury Federation promotes the centralization of care as the SCI population is a small group of people with a diagnosis that demands the highly-specialized knowledge of a wide range of medical, clinical and counseling personnel over a long period of time (European Spinal Cord Injury Federation, 2008). Studies showed that persons with SCI bypass closer general hospitals to visit specialist SCI centers which are further away (LaVela, Smith, Weaver, & Miskevics, 2004). The concept that people reside in an area that is different from the area where they receive healthcare services is described as “patient migration” (Nante et al., 2004). Previous studies on access to healthcare services have shown that the patients' selection of distant hospitals was related to higher severity of illness (Adams,

* Correspondence to: Swiss Paraplegic Research, Guido A. Zäch-Strasse 4, CH-6207 Nottwil, Switzerland. Tel.: +41 41 939 66 30; fax: +41 41 939 65 79.
E-mail address: armin.gemperli@paraplegie.ch (A. Gemperli).

http://dx.doi.org/10.1016/j.ssmph.2016.04.004

Houchens, Wright, & Robbins, 1991; Basu & Mobley, 2007; Welch, Larson, & Welch, 1993), higher complexity of treatment (White & Morrisey, 1998), younger age (Adams et al., 1991; Tai, Porell, & Adams, 2004) and being male (Buczko, 1992; Hogan, 1988). These findings suggest that persons with SCI are more likely to travel than the general population in order to reach suitable healthcare services. However, mobility impairment or other factors related to the comprehensive impact SCI has on person's life, may present obstacles to reaching these specialist healthcare services.

Switzerland has a universal healthcare system with health insurance compulsory for everyone and supplementary accidental insurance mandatory for the working population, provided by private companies (Daley, Gubb, Clarke, & Bidgood, 2007). Basic insurance benefits are determined by law and are consistent among all insurance providers. Delivery and funding of healthcare falls into the jurisdiction of the 26 cantons of Switzerland. The current study examines inpatient hospitalizations for the years 2010 and 2011. These are the two years before the introduction of a new hospital financing system with diagnosis-related group (DRG) system in Switzerland in 2012. At that time basic health insurance generally covered inpatient hospitalizations within the canton of residence (Crivelli, 2007; Wiedenhofer & Keppler, 2014). Treatments outside the residential canton were covered only if the treatment could not be adequately provided within the canton, in medical emergencies, or when a supplementary, optional insurance coverage was purchased. Accidental insurance covers health-related costs regardless of canton of hospitalization. Each canton of Switzerland is equipped with a general hospital that can deliver routine treatments; but only five of the 26 cantons, those with large urban centers, have hospitals that offer a fuller range of services. For initial care following SCI, there are four specialist centers that are designated for rehabilitation. These centers also provide yearly check-ups and treatment of secondary conditions that commonly occur in individuals with SCI.

The objective of this study was to compare the patient migration patterns for secondary health conditions in persons with SCI with the general population and persons with other chronic health conditions in order to identify facilitators and barriers of access to distant healthcare services. This study focused on hospitalizations for treatments aimed at maintaining the health status in individuals with SCI. Hospitalizations for initial acute care management and acute rehabilitation were excluded. The specific aims were to (1) investigate the likelihood of persons with SCI to be hospitalized outside their residential canton as compared to persons with morbid obesity, rheumatic conditions, bowel disease and the general population; (2) determine socioeconomic, geographical, and medical characteristics associated with obtaining inpatient hospital care outside the residential canton; and (3) compare the effect of these characteristics between persons with SCI and the general population.

2. Materials and methods

2.1. Data sources

This is a registry study with hospitalization records from the Federal Hospital Discharge Statistics (HOST) database maintained by the Swiss Federal Statistical Office (FSO). The database contains a detailed record of inpatient hospital admissions covering 98% of all expected inpatient cases in Switzerland from 99% of all hospitals (Swiss Federal Statistical Office, 2012). Socioeconomic and medical information of 2,708,942 hospitalizations were examined for the years 2010 and 2011. This study was waived by the ethics committee northwest/central Switzerland because of its retrospective nature. A data protection contract was signed with the FSO. The hospitalization records were irreversibly pseudonymized by the data providers, with IDs unique to identify the patients (Swiss Federal Statistical Office, 1997). Since the pseudonymization procedure is prone to misclassifications, a plausibility check of the hospital records was performed to identify patient IDs with implausibly altering sexes and ages. Hospitalizations that were found inconsistent in patient characteristics were assigned a new patient ID, which resulted in 11,428 new unique IDs. Furthermore records with patient IDs that appeared more than 50 times over the two year study period were deemed implausible and removed (1,772 cases) as well as hospitalizations of patients who were declared 16 years or older but coded as being admitted to hospital at birth (35 cases).

2.2. Study populations

Patient migration patterns of persons with SCI were compared to the general population hospitalized and to other health conditions that are similar to SCI regarding the comprehensive effect they have on a person's life. Comparator health conditions were required to be risk factors for secondary health conditions, have chronic manifestations and an age distribution similar to that of SCI. For that reason morbid (severe) obesity, rheumatic conditions, and bowel disease (celiac disease, Crohn's disease, and ulcerative colitis) were identified in the HOST database via disease codes using ICD-10-GM (German Modification) (Fig. 1). The digestive tract which is affected in bowel disease is often also impaired in persons with SCI. Like in SCI, rheumatic conditions and morbid obesity may lead to mobility impairments. All these characteristics might affect the likelihood of hospitalizations outside the residential canton. However, there were no a priori expectation about the need for specialized services in the comparison populations. For morbid obesity, only cases due to excess calories were included. The ICD-10-GM codes for rheumatic conditions (Thomas, Symmons, Brewster, Black, & Macfarlane, 2003) and bowel disease (Vestergaard & Mosekilde, 2002) were chosen in alignment with previous studies investigating these diseases. SCI hospitalizations were selected in alignment with the inclusion criteria defined by the Swiss Spinal Cord Injury (SwiSCI) Cohort Study, the largest community-survey on persons with SCI in Europe (Post et al., 2011). Acute traumatic hospitalizations of SCI and hospitalizations for first rehabilitation were excluded by removing hospitalizations with SCI coded either as principal diagnosis or as hospitalizations for acute traumatic spinal cord injury (acute injury of nerves and spinal cord; S14.x, S24.x, S34.x). To further shift the focus on treatments aimed at health maintaining, re-hospitalizations of persons with SCI were excluded if they happened within 18 days after an acute hospitalization. The 18 days were chosen in alignment with Swiss DRG guidelines for case consolidations (Swiss DRG AG, 2013). In alignment with the SwiSCI study, hospitalizations of all study populations were excluded for patients younger than 16 years of age and patients not residing in Switzerland. Hospitalizations of persons with SCI were excluded when they suffered from spina bifida, multiple sclerosis, amyotrophic lateral sclerosis or Guillain-Barré syndrome (Post et al., 2011). Admissions by ambulance were excluded, in order to strengthen the focus on persons who autonomously choose their care provider. Patients covering multiple of the studied health conditions (SCI, morbid obesity, rheumatic condition and bowel disease) were excluded from the study populations in order to zero out disease interaction effects.

2.3. Geographical characteristics

The patients' place of residence was recorded at the cantonal level (26 cantons), plus at a subdivision of 705 zones, containing between 3,500 and 10,000 inhabitants, called MedStat regions (Swiss Federal Statistical Office, 2010). For the mapping, a broader

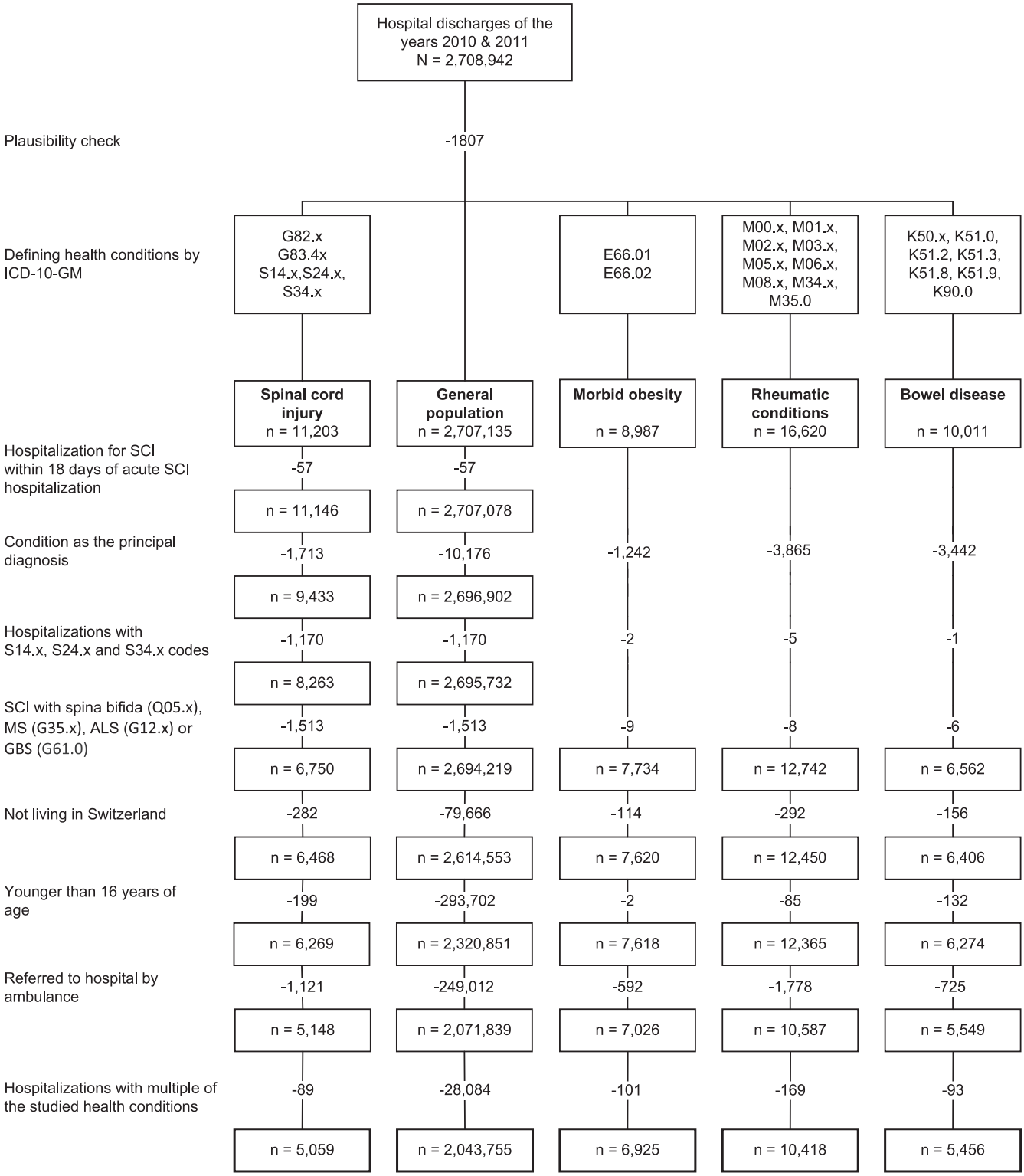

Fig. 1. Definition of study populations. *Abbreviations:* MS: Multiple sclerosis; ALS: Amyotrophic lateral sclerosis; GBS: Guillain-Barré syndrome. Hospitalizations were selected for the analysis via disease codes using ICD-10-GM (German Modification) (first branch from top). The negative numbers between boxes show the excluded hospitalizations when applying the exclusion criteria indicated on the far left. To zero out disease interaction effects, patients covering multiple of the studied health conditions were excluded in a last step. The number of remaining cases used for the analysis are shown at the bottom in the boxes with bold frames, for the respective disease condition.

regionalization into 106 zones called MS region (MS = mobilité spatiale), as defined by the FSO in 1982 (Schuler, 2005), was derived. The information about regional language and degree of urbanization was provided by the FSO on a municipality level, with the possibility to assign municipalities to MedStat regions and vice versa. If MedStat regions contained municipalities with different local languages, then the language spoken by the majority of the population was adopted. Romansh speaking regions were considered as German speaking. The degree of urbanization was adapted by the definition used in the Federal

Population Census 2000 (Schuler, 2005). It has four levels: core city of an agglomeration, isolated city, agglomeration of a city, and rural area. For this study no distinction between core city of an agglomeration and isolated city was made. The degree of urbanization of a MedStat region was defined according to the municipality with the highest degree of urbanization. Car travel times from the place of residence (MedStat region) to the largest hospital in the canton of treatment were estimated for out-of-canton hospitalizations using the Google Maps Directions API (Google Developers, 2016). The largest hospital in the canton of treatment was chosen, because the true place of hospitalization within the canton was not available from the HOST database for reasons of data protection.

2.4. SCI lesion characteristics and Charlson comorbidity index

SCI-specific information of severity of injury (complete: G82.x0, G82.x2 or G83.40; incomplete: G82.x1, G82.x3 or G83.41) and lesion level (paraplegia: G82.0x-G82.2x; tetraplegia: G82.3x-G82.5x; detailed: G82.6x) were retrieved from the ICD-10-GM codes. A morbidity score was calculated from the ICD-10-GM codes according to Quan's updated version of the Charlson comorbidity index (Quan et al., 2011) using all diagnoses including the principle diagnosis. All remaining individual level variables were available directly from the HOST database.

2.5. Regression analysis

Every SCI hospitalization was case matched with four hospitalizations from the general population and one hospitalization from the health conditions morbid obesity, rheumatic condition and bowel disease. Matching for sex, age, class of insurance and language region was performed using a genetic matching algorithm with replacement using the R package Matching (Sekhon, 2011). The effect of the health conditions on visiting hospitals outside the residential canton was examined using a logistic mixed effects model (Bates, Mächler, Bolker, & Walker, 2015) with the subject pair determined in the matching process as random effect. Separate logistic mixed effects models for the SCI and the general population were applied to investigate the effect of sex, age, insurance class and type, language region, degree of urbanization, type of admission, and degree of morbidity on hospitalizations outside of the residential canton. The model for SCI further included lesion level and severity as independent variables. In both models patient ID was deployed as random effects to correct for multiple hospitalizations per person over the two years course.

2.6. Analysis of unadjusted data

The proportion of persons who were hospitalized outside of the residential canton at least once during the course of two years was plotted for every year of age in persons with SCI and the general population. A change point in the relative frequencies of hospitalizations outside the residential canton by age was determined using optimization (Nelder-Mead method) of a regression model with change in slope. The confidence interval for the change point was constructed using nonparametric bootstrap. The effect of the lesion level on the propensity of visiting hospitals outside the residential canton was plotted separately for complete and incomplete injuries. A map depicting relative frequencies of hospitalizations outside the residential canton of persons with SCI was created using the R package ggplot2 (Wickham, 2009). The relative frequencies were calculated for 106 MS-regions. Regions with no hospitalizations were merged with the bordering region of the same canton with the highest number of hospitalizations. Relative frequencies of principal diagnoses categorized as ICD-10-GM chapters and relative frequencies of hospitalizations outside of the residential canton for every ICD-10-GM chapter were calculated for persons with SCI and a matched sample of the general population. ICD-10-GM chapters with low numbers of hospitalizations or with unspecific information were excluded from the analysis. To test for significant differences in the relative frequencies between persons with SCI and the general population Fisher's exact tests were performed. Data preparation and all analyzes have been performed using R version 3.1.2 (2014-10-31) (R Core Team, 2014).

3. Results

During the years 2010 and 2011, 2,708,942 discharges for inpatient hospitalization were recorded in Switzerland. After screening for ICD-10-GM codes and applying exclusion criteria, the study populations consisted of 3,695 persons with SCI (5,059 hospitalizations), 1,334,599 persons from the general population (2,043,755 hospitalizations), 6,111 persons with morbid obesity (6,925 hospitalizations), 7,562 persons with rheumatic conditions (10,418 hospitalizations), and 4,129 persons with bowel disease (5,456 hospitalizations) (Fig. 1). An analysis of the hospitalizations excluded from the study indicated that persons with bowel disease were admitted for their main health condition every third time (34.4%) and thereby more than persons of the other studied health conditions including SCI (15.4%). The proportion of hospitalizations from persons not living in Switzerland was higher in the SCI population (4.2%) compared to the general population (3.0%) and the other health conditions. Persons with SCI were more often referred to hospital by ambulance (17.9%) than the general population (10.7%), persons with morbid obesity (7.8%), rheumatic conditions (14.4%), and bowel disease (11.6%).

3.1. Summary of baseline characteristics

Male patients were responsible for 61.4% of hospitalizations in the SCI population (Table 1). The fractions of male hospitalizations were smaller in the general population (44.7%), in persons with morbid obesity (37.2%), rheumatic conditions (28.2%) and bowel disease (43.1%). Hospitalization costs were more often covered by a semi-private or private insurance in persons with SCI (22.0%) as compared to persons with morbid obesity (20.9%), but less often compared to the general population (25.7%), persons with rheumatic conditions (28.4%) and persons with bowel disease (27.0%). Costs were covered by the accidental insurance more frequently in the SCI population (10.2%), as compared to the general population (5.8%) and the other health conditions. The proportion of hospitalizations by French speaking persons was lower in the SCI population (19.2%) compared to the general population (23.0%) whereas the fraction of hospitalizations by Italian speaking persons was higher in the SCI population (6.1%) compared to general population (5.3%). Hospital stays were longer in persons with SCI (median 12 days, inter quartile range [IQR] 20 days) compared to the general population (median 5 days, IQR 8 days) and patients of the other three health conditions. Emergency admissions were more common in persons with SCI (41.3%) compared to the general population (37.0%) and persons with morbid obesity (29.0%), and less frequent compared to persons with rheumatic conditions (42.9%) and bowel disease (51.6%). The morbidity score (updated Charlson comorbidity index) was highest in the SCI population (mean 2.9) and much higher than in the general population (mean 0.5). Among all hospitalizations by persons with SCI, paraplegics were responsible for 55.6%, tetraplegics for 36.3% and persons with the cauda equina syndrome for 8.0% of hospitalizations. Information about lesion level details and severity of the injury was missing in 65.8% and 41.0% of cases, respectively (Table 2).

Table 1
Socioeconomic, geographic and medical characteristics of the sample populations, years 2010 and 2011.

	SCI	General population		Morbid obesity		Rheumatic conditions		Bowel disease	
	Original	Original	SCI matched 4:1	Original	SCI matched 1:1	Original	SCI matched 1:1	Original	SCI matched 1:1
	***N*[a]=5,059**	*N*=2,043,755	*N*=20,236	*N*=6,925	*N*=5,059	*N*=10,418	*N*=5,059	*N*=5,456	*N*=5,059
Number of patients	**3,695**	1,334,599	16,890	6,111	2,604	7,562	2,738	4,129	2,371
Socioeconomic characteristics									
Sex, male (%)	**61.4**	44.7	61.4	37.2	61.4	28.2	61.4	43.1	61.4
Age in years – mean (SD)	**59.7 (17.3)**	57.1 (20.3)	59.7 (17.3)	57.9 (15.9)	59.8 (17.0)	69.4 (13.7)	59.7 (17.3)	55.7 (18.9)	59.7 (17.2)
Insurance class (%)									
Basic	**78.0**	74.2	78.0	79.0	78.0	71.6	78.0	73.1	78.0
Semi-private	**13.1**	16.0	13.1	13.7	13.1	19.4	13.1	18.3	13.1
Private	**8.9**	9.7	8.9	7.2	8.9	9.0	8.9	8.7	8.9
Insurance type (%)									
Health insurance	**86.8**	92.2	91.8	95.9	94.1	97.8	94.9	96.9	97.2
Accidence insurance	**10.2**	5.8	6.7	3.0	4.7	1.4	3.9	2.0	2.2
Disability insurance	**0.5**	0.2	0.1	0.1	0.3	0.0	0.0	0.0	0.0
Other or unknown	**2.5**	1.8	1.4	1.0	0.9	0.8	1.2	1.1	0.6
Geographic characteristics									
Language region (%)									
German	**74.7**	71.7	74.7	94.5	74.7	75.1	74.7	79.2	74.7
French	**19.2**	23.0	19.2	4.1	19.3	22.3	19.2	19.1	19.2
Italian	**6.1**	5.3	6.1	1.4	6.0	2.6	6.1	1.8	6.1
Degree of urbanization (%)									
City	**32.9**	31.6	30.6	28.4	28.4	31.6	31.8	30.2	30.8
City agglomeration	**44.8**	47.9	48.2	47.0	44.2	45.3	45.2	50.4	50.5
Rural area	**22.3**	20.5	21.3	24.6	27.4	23.1	23.0	19.4	18.7
Medical characteristics									
Length of stay[b] in days,									
Mean (SD)	**24.0 (44.5)**	12.5 (145.7)	12.5 (128.8)	10.1 (11.2)	10.4 (11.7)	13.6 (15)	12.6 (14.8)	10.8 (13.5)	11.1 (12.3)
Median (IQR)	**12 (20)**	5 (8)	6 (8)	7 (8)	7 (10)	9 (12)	8 (11)	7 (9)	7 (10)
Admission type (%)									
Scheduled	**56.1**	61.2	62.3	70.6	71.8	55.1	54.4	47.3	47.6
Emergency	**41.3**	37.0	35.9	29.0	27.5	42.9	44.4	51.6	51.7
Other	**2.6**	1.8	1.8	0.4	0.7	2.0	1.2	1.1	0.7
Morbidity score[c] – mean (SD)	**2.9 (1.8)**	0.5 (1.3)	0.6 (1.4)	0.7 (1.3)	0.7 (1.3)	1.6 (1.3)	1.4 (1.4)	0.6 (1.4)	0.7 (1.5)
Out-of-canton treatment (%)	**26.5**	14.2	14.9	18.4	18.7	14.1	15.2	15.9	14.3
Travel time (in min)[d] – mean (SD)	**69.6 (40.3)**	52.9 (40.0)	51.6 (38.9)	43.2 (31.0)	55.6 (44.3)	53.2 (40.8)	63.2 (47.8)	48.9 (42.4)	52.1 (45.9)

Abbreviations: SCI: spinal cord injury; SD: standard deviation; IQR: inter quartile range.

[a] *N* refers to number of hospitalizations.

[b] Length of stay of a patient is counted as the date of discharge minus the date of admission (OECD, 2015).

[c] Updated Charlson comorbidity index calculated with principal diagnosis and side diagnoses. Spinal cord injury and rheumatic conditions were used to calculate the updated Charlson comorbidity index and had a weight of two and one, respectively.

[d] Travel time from the place of residence to the place of hospitalization in minutes by car for out-of-canton hospitalizations.

Table 2
Injury characteristics of hospitalizations by patients with spinal cord injury.

Lesion level (%)	Tetraplegia	36.3
	Paraplegia	55.6
	Cauda equina syndrome	8.0
Lesion level detail[a] (%)	C1–C3	1.6
	C4–C5	5.5
	C6–C8	3.4
	T1–T6	8.0
	T7–T10	6.4
	T11–L1	6.3
	L2–S5	3.0
	Unknown	65.8
Severity (%)	Complete lesion	20.7
	Incomplete lesion	38.3
	Unknown	41.0

[a] The lesion level is the lowest motor intact spinal cord segment.

3.2. Effect of health condition on hospitalization outside of the residential canton and travel time

Persons with SCI were more likely hospitalized outside of their residential canton (odds ratio (OR) 2.07, 95%-confidence interval (CI) 1.87–2.29) than persons from a matched sample of the general population (Table 3). They were also more likely hospitalized outside of their residential canton than persons with morbid obesity (OR 1.25, 95%-CI 1.15–1.35), bowel disease (OR 1.11, 95%-CI 1.01–1.22) and rheumatic conditions (OR 1.07, 95%-CI 0.96–1.18), albeit in a lesser extent. Average car travel times for out-of-canton hospitalizations were longer for persons with SCI (70 min, 95%-CI 67–72 min) compared to the general population (52 min, 95%-CI 50–53 min), persons with morbid obesity (56 min, 95%-CI 53–58 min), rheumatic conditions (63 min, 95%-CI 60–66 min), and bowel disease (52 min, 95%-CI 48–55 min).

3.3. Effect of age on hospitalization outside of the residential canton

With increasing age, the probability of being hospitalized outside of the residential canton decreased. Persons with SCI older than 75 years were much less likely (OR 0.18, 95%-CI 0.08–0.40) hospitalized outside of their residential canton compared to the youngest age group (16–30 years) (Table 4). The difference between the youngest and the oldest age group was less distinct in the general population (OR 0.64, 95%-CI 0.60–0.68). Crude relative frequencies of persons with at least one hospitalization outside of the residential canton showed a decline with increasing age in persons with SCI (Fig. S1A) and the general population (Fig. S1B) after a certain age. The change

Table 3
Multivariable logistic regression for obtaining treatment outside of the residential canton for matched populations.

	Likelihood of out-of-canton admission Odds ratio (95%-CI) N=39,915
General population	Reference
Spinal cord injury	2.07 (1.87–2.29)
Morbid obesity	1.25 (1.15–1.35)
Rheumatic conditions	1.07 (0.96–1.18)
Bowel disease	1.11 (1.01–1.22)

Mixed-effects logistic model adjusted for characteristics listed in Table 4 as fixed effects and the matching ID as random effects.
Abbreviations: CI: Confidence interval.

point in age, when hospitalizations outside of the residential canton start declining, was calculated in the SCI population at 59.0 years of age (95%-CI = 45.0–70.9) and at 60.8 years of age (95%-CI = 30.1–66.6) in the general population.

3.4. Effect of insurance coverage on hospitalization outside of the residential canton

Persons with semi-private or private health insurance were more likely hospitalized outside of their residential canton than persons with basic health insurance in the SCI and general population (OR 2.32 and 2.50 for semi-private and private health insurance as compared to basic health insurance, for the SCI population, and OR 1.77 and 2.26 for the general population, respectively). Individuals with SCI and the general population were more likely hospitalized outside of their residential canton when costs were covered by accidental insurance (OR 16.40, 95%-CI 8.27–32.51 and OR 1.99, 95%-CI 1.88–2.10 in persons with SCI and the general population, respectively) or other insurance types (OR 25.45, 95%-CI 8.99–72.07 and OR 4.80, 95%-CI 4.46–5.17 in persons with SCI and the general population, respectively) than when costs were covered by the basic health insurance. In persons with SCI, driving times to hospitals for out-of-canton hospitalizations that were covered by accidental insurances were longer (mean 83 min, 95%-CI 79–87 min) than for out-of-canton hospitalizations covered by health insurances (mean 64 min, 95%-CI 61–66 min). No such differences in travel times were observed in the general population or the comparator conditions.

3.5. Effect of geographic characteristics on hospitalization outside of the residential canton

Unlike in the general population where persons from French speaking regions were less likely hospitalized outside of their residential canton than persons from German speaking regions (OR 0.48, 95%-CI 0.46–0.51), the migration pattern of persons with SCI was not significantly different among these two language regions (OR 1.05, 95%-CI 0.68–1.62) (Table 4). Persons from Italian speaking regions were least likely hospitalized outside of their residential canton in persons with SCI (OR 0.25, 95%-CI 0.11–0.55) and in the general population (OR 0.37, 95%-CI 0.33–0.41) compared to persons from German speaking regions. The probability of hospitalizations outside of the residential canton was higher in persons with SCI living in an agglomeration of a city (OR 2.62, 95%-CI 1.74–3.95) or in rural areas (OR 3.43, 95%-CI 2.13–5.52) than when living in urban areas. A spatial depiction of out-of-canton hospitalizations by region of residence showed great spatial heterogeneity (Fig. 2). High rates of remote hospitalizations were found in bilingual cantons and rural regions, especially when bordering urban cantons. Urban regions and regions with specialist centers in the proximity showed low outmigration.

Table 4
Multivariable mixed effects logistic regression for factors associated with obtaining treatment outside of the residential canton.

	Spinal cord injury Odds ratio (95%-CI) *N*=4,927	General population Odds ratio (95%-CI) *N*=2,002,333
Socioeconomic characteristics		
Sex, male	1.13 (0.80–1.59)	1.06 (1.03–1.11)
Age (years)		
16–30	Reference	Reference
31–45	1.01 (0.50–2.05)	0.90 (0.85–0.96)
46–60	0.87 (0.45–1.69)	0.91 (0.86–0.96)
61–75	0.44 (0.22–0.86)	0.81 (0.76–0.86)
76+	0.18 (0.08–0.40)	0.64 (0.60–0.68)
Insurance class		
Basic	Reference	Reference
Semi-private	2.32 (1.40–3.83)	1.77 (1.70–1.85)
Private	2.50 (1.40–4.46)	2.26 (2.16–2.38)
Insurance type		
Health insurance	Reference	Reference
Accidental insurance	16.40 (8.27–32.51)	1.99 (1.88–2.10)
Others[a]	25.45 (8.99–72.07)	4.80 (4.46–5.17)
Geographic characteristics		
Language region		
German	Reference	Reference
French	1.05 (0.68–1.62)	0.48 (0.46–0.51)
Italian	0.25 (0.11–0.55)	0.37 (0.33–0.41)
Degree of urbanization		
City	Reference	Reference
City agglomeration	2.62 (1.74–3.95)	1.40 (1.34–1.46)
Rural area	3.43 (2.13–5.52)	1.99 (1.90–2.10)
Medical characteristics		
Type of admission[b]		
Scheduled	Reference	Reference
Emergency	0.25 (0.18–0.35)	0.15 (0.15–0.16)
Morbidity score[c]		
0	Not applicable[d]	Reference
1	Not applicable	0.78 (0.73–0.82)
2	Reference	0.74 (0.71–0.78)
3	1.01 (0.57–1.80)	0.67 (0.62–0.73)
4	0.76 (0.46–1.25)	0.65 (0.58–0.73)
5	0.91 (0.34–2.43)	0.63 (0.51–0.79)
6+	0.58 (0.34–0.98)	0.68 (0.63–0.73)
Lesion level		
Tetraplegia	Reference	
Paraplegia	0.80 (0.57–1.13)	
Cauda equina syndrome	0.52 (0.27–1.00)	
Severity		
Complete lesion	Reference	
Incomplete lesion	0.31 (0.20–0.48)	
Unknown	0.16 (0.10–0.26)	

[a] Disability insurance, military insurance, self-payers and unknown insurance.
[b] Hospitalizations (132 discharges in persons with spinal cord injury and 36,501 discharges of the general population) listed as others in Table 1 were excluded in the regression model.
[c] Updated Charlson comorbidity index calculated with principal diagnosis and side diagnoses.
[d] Spinal cord injury was used to calculate the updated Charlson comorbidity index and has a weight of two.

3.6. Effect of morbidity score and admission type on hospitalization outside of the residential canton

Compared to planned admissions, hospitalizations outside of the residential canton were less likely in emergency cases for persons with SCI (OR 0.25, 95%-CI 0.18–0.35) and in the general population (OR 0.15, 95%-CI 0.15–0.16). Higher morbidity scores were associated with lower probabilities of out-of-canton hospitalizations in persons with SCI and the general population.

Morbidity scores higher than five showed a statistically significant negative effect on the probability to be hospitalized outside of the residential canton in the SCI population

3.7. Effect of lesion characteristics on hospitalization outside of the residential canton

Complete injury (OR 3.21, 95%-CI 2.09–4.91) leads to more out-of-canton hospitalizations compared to incomplete paralysis. A trend towards decreasing frequencies for out-of-canton hospitalizations with lower lesion levels was observed, looking at unadjusted relative frequencies of hospitalizations outside of the residential canton stratified for complete (Fig. 3A) and incomplete (Fig. 3B) injuries. This was similar for persons with incomplete and complete injuries, with higher relative frequencies for the latter.

3.8. Effect of disease categories on hospitalization outside of the residential canton

Infectious diseases (5.2% vs 2.3%), neoplasms (15.9% vs. 11.2%), diseases of the nervous system (12.4% vs 2.9%), diseases of the skin (6.1% vs. 1.3%), urinary tract (8.0% vs. 6.6%) and congenital malformations (0.7% vs. 0.3%) were markedly more frequent in persons with SCI than in a matched sample of the general population (Table 5). In the general population hospitalizations for mental disorders (8.2% vs. 1.5%), diseases of eyes and ears (1.8% vs. 0.3%), diseases of the cardiac system (14.3% vs. 8.8%), diseases of the digestive system (10.4% vs 6.1%), pregnancy (3.3% vs. 0.4%), and injuries (12.3% vs 10.3%) were markedly more frequent. Being hospitalized of outside the residential canton was more likely in persons with SCI for all ICD-10-GM categories except for ear diseases and pregnancy. For diseases of the endocrine system (25.5%

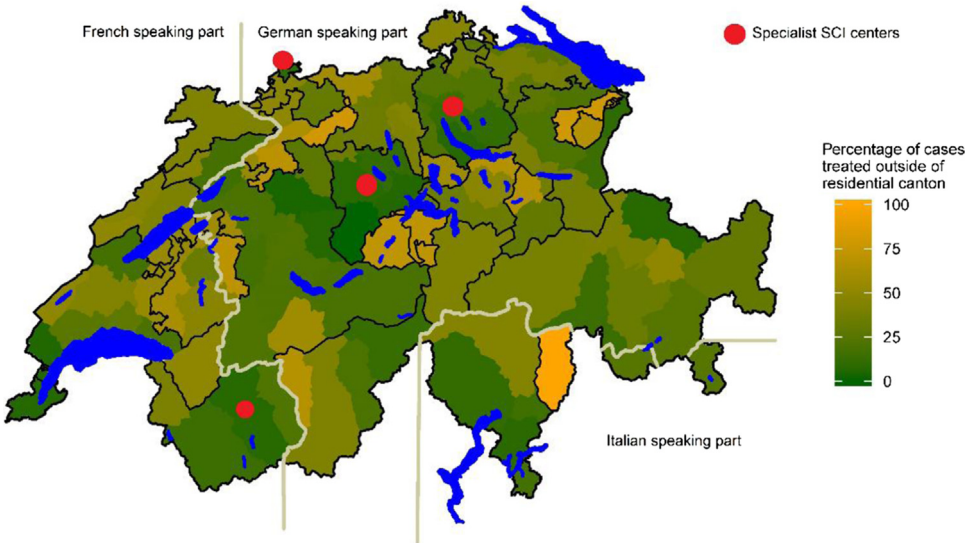

Fig. 2. Relative frequencies of hospitalizations outside of the residential canton by Swiss region.

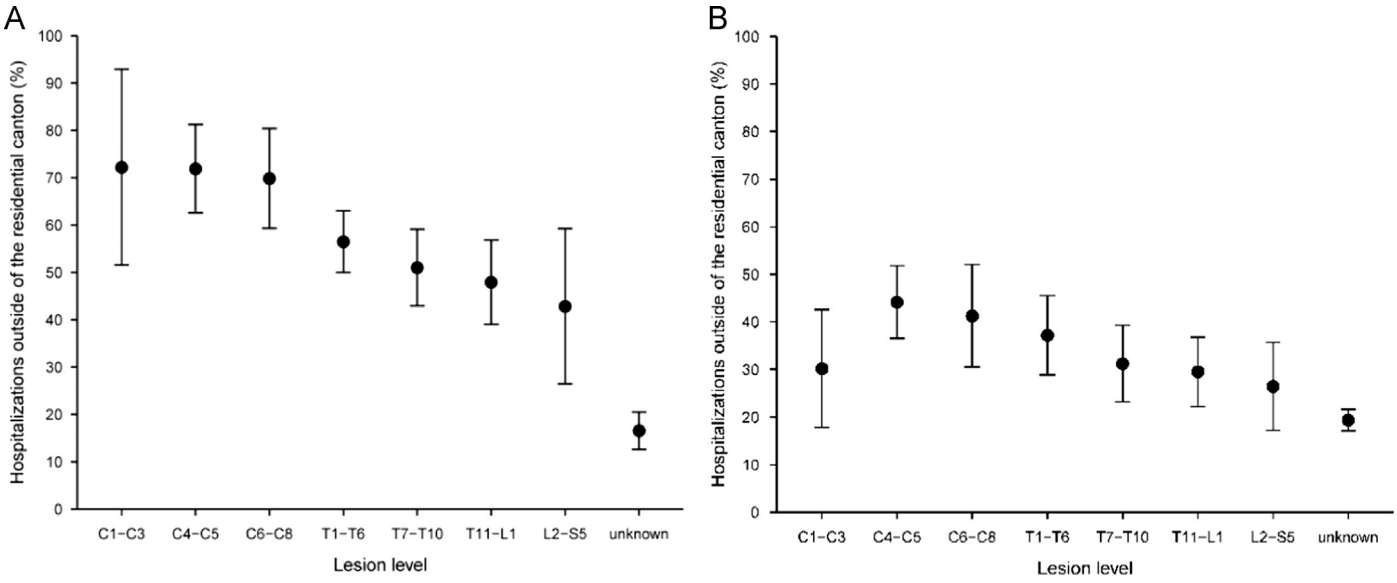

Fig. 3. (A). Hospitalizations outside the residential canton by lesion levels in persons with spinal cord injury with complete injuries. (B) Hospitalizations outside the residential canton by lesion levels in persons with spinal cord injury with incomplete injuries. Error bars indicate interval estimate of population proportion at 95% confidence level. *Abbreviations*: C: Cervical; T: Thoracic; L: Lumbar; S: Sacral.

Table 5
Relative frequencies of principal diagnoses and hospitalizations outside of the residential canton in persons with spinal cord injury and a matched sample of the general population.

ICD-10 chapter	Type of diagnosis	Relative frequency (%)		Out-of-canton hospitalizations (%)	
		Spinal cord injury[a]	General population[b]	Spinal cord injury	General population
I	Infections	5.2**	2.3	14.4**	7.8
II	Neoplasms	15.9**	11.2	19.0**	14.1
III	Blood	0.5*	0.8	20.8	8.0
IV	Endocrine system	1.1	1.5	25.5**	8.3
V	Mental disorders	1.5**	8.2	20.8*	11.5
VI	Nervous system	12.4**	2.9	30.6**	19.3
VII	Eye	0.2**	1.3	25.5	22.7
VIII	Ear	0.1**	0.5	14.3	19.3
IX	Cardiac system	8.8**	14.3	25.9**	18.7
X	Respiratory system	4.8	5.0	18.4**	10.7
XI	Digestive system	6.1**	10.4	23.1**	9.3
XII	Skin	6.1**	1.3	45.6**	10.6
XIII	Musculoskeletal system	18.0	17.8	27.6**	19.5
XIV	Urinary tract	8.0**	6.6	31.4**	11.2
XV	Pregnancy	0.4**	3.3	10.0**	11.9
XVII	Congenital malformations	0.7**	0.3	43.8	23.1
XIX	Injury	10.3**	12.3	30.7**	16.8

* Statistical significance at 5% level.
** Statistical significance at 1% level.
[a] 4842 hospitalizations of persons with spinal cord injury.
[b] 19,263 hospitalizations of the general population.

vs. 8.3%), digestive system (23.1% vs. 9.3%), skin (45.6% vs. 10.6%), and urinary tract system (31.4% vs. 11.2%) persons with SCI were more than two times more often hospitalized outside of the residential canton than the general population.

4. Discussion

Persons with SCI were more likely hospitalized outside of their residential canton for secondary health conditions and were also traveling longer to the out-of-canton place of hospitalization compared to the general population and persons with morbid obesity, rheumatic conditions, and bowel disease. With increasing age, patients were more likely to be hospitalized within their residential canton. Hospitalizations outside the residential canton were more likely if private health insurances, accidental insurances or other specialized insurances covered the costs. This study suggests that inpatient migration patterns are strongly determined by place of residence, socioeconomic characteristics, and health conditions. Persons with complete or higher-level injuries visited hospitals outside their residential canton at higher rates compared to persons with incomplete or low level injuries. The fact that persons with SCI left their canton of residence for treatment of most disease categories more often than the general population and persons of other health conditions indicates that they have an increased need for specialist healthcare across many health conditions. It underlines the comprehensive impact SCI has on a person's health. Diseases for which persons with SCI were most often hospitalized outside of the residential canton (diseases of the digestive system, skin and urinary tract) coincide with the most often mentioned secondary health conditions in persons with SCI in other studies (Charlifue, Jha, & Lammertse, 2010; Dryden et al., 2004).

In consistence with previous studies, elderly persons were more likely hospitalized within their home region (Adams et al., 1991; Tai et al., 2004). Older adults increasingly experience non-traumatic causes of SCI (McKinley, Seel, & Hardman, 1999). Therefore, they might be under principal medical treatment for other diseases at acute phases and fail to complete the whole SCI rehabilitation procedure at specialist centers and subsequently lack specialist follow up care. A further explanation of the finding might be that the priority of elderly patients changes to general medicine aspects and specialist geriatric wards were considered a better choice for their treatment. The higher proportion of hospitalizations within the residential canton in elderly persons might possibly be the effect of an overall increase in hospitalizations in the elderly with disproportionately more in-canton hospitalizations. However, this was ruled out, by investigating the crude number of patients with at least one hospitalization outside of the residential canton during the study time. Out-of-canton hospitalizations were not only declining by age relative to hospitalizations within the residential canton but also in absolute numbers (see Supplemental Figs. S1A & S1B). Therefore elderly persons with SCI might be at risk of undersupply of specialist healthcare, especially when suffering from high lesion level and complete injury.

In contrast to earlier findings (Adams et al., 1991; Basu & Mobley, 2007; Welch et al., 1993) higher severity-of-illness was associated with less patient migration. This result may be explained by the different measures of severity-of-illness in other studies. The updated Charlson comorbidity index (Quan et al., 2011) applied in this study incorporates common diseases which can be treated adequately in most cantons. A high Charlson morbidity score may also immobilize people, which is a possible explanation for the low frequencies of out-of-canton hospitalizations observed with high scores. SCI and rheumatic conditions were comorbidity variables used to calculate the updated Charlson comorbidity index with weights of two and one, respectively. Compared to the original and matched general population, the comorbidity score of the SCI population remained markedly higher even when the SCI condition was excluded from the index.

Persons with basic health insurance were found to be less likely hospitalized outside their residential canton, which is in accordance to restrictions in insurance coverage. Highest probabilities for out-of-canton hospitalizations were observed for patients with out-of-pocket payments or when disability, military, accidental or private health insurances covered the costs. None of these insurances limit their payments to hospitalizations within the residential canton. The accidental insurance covers costs in cases of accidents or for sequels of an accident such as a SCI. Physicians and insurers mutually decide whether a disease is associated with the initial SCI. Decisions in favor of accidental insurances are more likely when physicians at specialist centers were involved. Additionally, treatments carried out at specialist centers may better qualify to be covered by accidental insurances. Hospitalizations of persons with SCI are more likely covered by accidental insurance, what may partly explain the high out-of-canton hospitalization rates in this condition. The fact that specialized centers are more likely not in the canton of residence may further affect the finding and suggests that persons with SCI are more affected by limitations in payment for out-of-canton hospitalizations than the general population.

A very low propensity of out-of-canton treatment was found for patients from Italian speaking regions. The Italian speaking regions are separated from the rest of Switzerland by mountains. In this part of Switzerland no specialist SCI centers or teaching hospitals are present. Minority regional language might represent barriers of access to specialist healthcare services through the pathway of long distance traveling. Persons with SCI seem to prefer hospitalizations within their language region. This was

illustrated by two findings. Firstly, there was a high outmigration of the Italian speaking region Val Mesolcina located in the predominantly German speaking canton of Grisons in eastern Switzerland. Eighty percent of persons with SCI from Val Mesolcina were hospitalized in the neighboring, Italian speaking canton of Ticino. Secondly, a high percentage of persons with SCI living in the German part of the bilingual canton of Valais were hospitalized outside of Valais despite the existence of an SCI center in the French part of the same canton. From cantons with large urban centers and teaching hospitals almost no outmigration was detected even in the absence of a specialist center. It is suggested that from these cantons only persons with very complex secondary health conditions leave their residential canton. This effect was seen, for example, for treatment of pressure ulcers where 45.8% of all cases were hospitalized in the canton of Lucerne, where the largest national specialist SCI center is based. In every other canton the majority of hospitalizations for pressure ulcers were obtained outside the residential canton. As a consequence the hospital length of stay in persons with SCI was highest in the canton of Lucerne, with its specialist center. Otherwise, the length of stay was found similar between all cantons and persons with SCI, the general population and the comparator conditions, with outliers of the cantons with a focus on rehabilitation clinics.

Despite the mobility impairments, persons with SCI travel often in order to obtain inpatient hospital care. The most severe forms of mobility impairments were associated with the highest likelihood of patient migration. It is a positive sign that mobility impairments, on a first glance, do not hinder access to healthcare services. This is important as persons with complete or high level lesions often suffer from severe secondary health conditions that often demand specialist knowledge. However, this study did not yet answer the question whether for example elderly or severely multimorbid persons with SCI face barriers to access of necessary healthcare services or whether they do not travel by purpose. Studies that investigate perceived access to healthcare would be best suitable to further examine this open question.

5. Limitations

This study relied on registry data, which was not collected with our research objectives in mind, and therefore their appropriateness for specific research questions needs to be judged on a case-by-case basis (Nathan & Pawlik, 2008). As of 2012 the DRG system is used for the calculation of all hospital charges except for rehabilitation, psychiatry, and palliative care. At least for the hospitalizations which fall under the coverage of the DRG system it can be expected that the data was of good quality as a consequence of the approaching system change. However, it is still possible that some diagnoses were not persistently coded, as there was no incentive to do so before the introduction of the DRG system in Switzerland. Incomplete coding may explain the large differences in frequency of admissions for diseases of the ears and eyes or for mental problems between persons with SCI and the general population. Persons with incomplete or low level injuries might not have been properly identified as persons with SCI. The high relative frequency of hospitalizations for neoplasms in persons with SCI were mainly due to secondary malignant neoplasms of bone or bone marrow (192 hospitalizations) and unspecified parts of the nervous system (29 hospitalizations). It is likely that some of these diseases lead to non-traumatic SCI (Nagata et al., 2003; New, Rawicki, & Bailey, 2002) and were therefore hospitalizations for newly acquired SCI and not for the envisaged health maintaining. Similar reasoning applies to diseases of the nervous system in persons with SCI. Disease codes for vascular myelopathies, inflammatory polyneuropathies or syringomyelia were prevalent in persons with SCI and are causes of SCI rather than consequences. A further study limitation was that the calculation of accurate travel times for hospitalizations was not possible, as the hospital location within a canton was not available from the HOST database. Intra-cantonal travel times could not be computed and out-of-canton hospitalizations were approximated with the largest hospital of a canton defined as the place of hospitalization. Typically, these hospitals are the main service providers and located in urban centers in close proximity of other hospitals.

6. Conclusion

Persons with SCI were hospitalized outside of their residential canton more likely than persons with other chronic health conditions or the general population and they drove longer to the out-of-canton place of hospitalization. Hospitalizations outside of the residential canton were more frequent in persons with high lesion levels or complete injuries compared to persons with low lesion levels and incomplete injuries. Facilitators of hospitalizations outside of the residential canton were private or accidental health insurances covering costs. Barriers to hospitalizations outside of the residential canton were old age, severe multimorbidity, financial coverage by basic health insurances, and living in a minority language region.

Acknowledgments

The authors would like to Wolfram Schwegmann for valuable input on ICD-10 coding as well as Brittany Perez and Natalie Grandy for editing the manuscript. We also thank the Swiss Federal Statistical Office for providing the hospital discharge data.

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.ssmph.2016.04.004.

References

Adams, E. K., Houchens, R., Wright, G. E., & Robbins, J. (1991). Predicting hospital choice for rural Medicare beneficiaries: the role of severity of illness. *Health Services Research*, *26*(5), 583–612.

Basu, J., & Mobley, L. R. (2007). Illness severity and propensity to travel along the urban–rural continuum. *Health Place*, *13*(2), 381–399.

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, *67*(1).

Bauman, W. A., & Spungen, A. M. (2008). Coronary heart disease in individuals with spinal cord injury: assessment of risk factors. *Spinal Cord*, *46*(7), 466–476.

Beatty, P. W., Hagglund, K. J., Neri, M. T., Dhont, K. R., Clark, M. J., & Hilton, S. A. (2003). Access to health care services among people with chronic or disabling conditions: patterns and predictors. *Archives of Physical Medicine and Rehabilitation*, *84*(10), 1417–1425.

Buczko, W. (1992). What affects rural beneficiaries use of urban and rural hospitals? *Health Care Financing Review*, *14*(2), 107–114.

Cardenas, D. D., Hoffman, J. M., Kirshblum, S., & McKinley, W. (2004). Etiology and incidence of rehospitalization after traumatic spinal cord injury: a multicenter analysis1. *Archives of Physical Medicine and Rehabilitation*, *85*(11), 1757–1763.

Charlifue, S., Jha, A., & Lammertse, D. (2010). Aging with spinal cord injury. *Physical Medicine and Rehabilitation Clinics of North America*, *21*(2), 383–402.

Chiodo, A. E., Scelza, W. M., Kirshblum, S. C., Wuermser, L. A., Ho, C. H., & Priebe, M. M. (2007). Spinal cord injury medicine. 5. Long-term medical issues and health maintenance. *Archives of Physical Medicine and Rehabilitation*, *88*(3 Suppl 1), S76–S83.

Crivelli, L. (2007). Abolishing cantonal barriers in hospital market. *Health Policy Monitor*. Retrieved from: ⟨http://wwwhpm.org/ch/a9/2.pdf⟩.

Daley, C., Gubb, J., Clarke, E., & Bidgood, E. (2007). *Healthcare systems: Switzerland*. London: The Institute for the Study of Civil Society.

Dryden, D. M., Saunders, L. D., Rowe, B. H., May, L. A., Yiannakoulias, N., Svenson, L. W., & Voaklander, D. C. (2004). Utilization of health services following spinal cord injury: a 6-year follow-up study. *Spinal Cord*, *42*(9), 513–525.

European Spinal Cord Injury Federation, (2008). ESCIF Policy Statement on the treatment, rehabilitation and life-long care of persons with spinal cord injuries (SCI). Retrieved August 10, 2015, from: http://www.escif.org/ESCIF,,policy_statement.htm.

Google Developers, (2016). The Google Maps Directions API. Retrieved April 6, 2016, from: ⟨https://developers.google.com/maps/documentation/directions/intro⟩.

Hogan, C. (1988). Patterns of travel for rural individuals hospitalized in New York State: relationships between distance, destination, and case mix. *The Journal of Rural Health*, *4*(2), 29–41.

Kim, J. G., Nam, H. S., Hwang, B., & Shin, H. I. (2014). Access to medical services in Korean people with spinal cord injury. *Annals of Rehabilitation Medicine*, *38*(2), 174–182.

LaVela, S. L., Smith, B., Weaver, F. M., & Miskevics, S. A. (2004). Geographical proximity and health care utilization in veterans with SCI&D in the USA. *Social Science Medicine*, *59*(11), 2387–2399.

McKinley, W. O., Seel, R. T., & Hardman, J. T. (1999). Nontraumatic spinal cord injury: incidence, epidemiology, and functional outcome. *Archives of Physical Medicine and Rehabilitation*, *80*(6), 619–623.

Myers, J., Lee, M., & Kiratli, J. (2007). Cardiovascular disease in spinal cord injury: an overview of prevalence, risk, evaluation, and management. *American Journal of Physical Medicine Rehabilitation/Association of Academic Physiatrists*, *86*(2), 142–152.

Nagata, M., Ueda, T., Komiya, A., Suzuki, H., Akakura, K., Ishihara, M., & Ito, H. (2003). Treatment and prognosis of patients with paraplegia or quadriplegia because of metastatic spinal cord compression in prostate cancer. *Prostate Cancer and Prostatic Diseases*, *6*(2), 169–173.

Nante, P. D. N., Ricchiardi, P. D. G., Farraj, D. O. al, Morgagni, D. S., Siliquini, D. R., Moirana, F., & Sassi, D. F. (2004). Hospital patient migration: analysis using a utility index In: W. Kirch (Ed.), *Public health in Europe* (pp. 293–316). Springer Berlin Heidelberg.

Nathan, H., & Pawlik, T. M. (2008). Limitations of claims and registry data in surgical oncology research. *Annals of Surgical Oncology*, *15*(2), 415–423.

New, P. W., Rawicki, H. B., & Bailey, M. J. (2002). Nontraumatic spinal cord injury: demographic characteristics and complications. *Archives of Physical Medicine and Rehabilitation*, *83*(7), 996–1001.

OECD, (2015). OECD Health Statistics 2015; Definitions, Sources and Methods. Retrieved August 10, 2015, from: ⟨http://stats.oecd.org/wbos/fileview2.aspx?IDFile=05c5f7a0-a813-4cc1-8a83-0d77343b5b9e⟩.

Penchansky, R., & Thomas, J. W. (1981). The concept of access: definition and relationship to consumer satisfaction. *Medical Care*, *19*(2), 127–140.

Post, M. W. M., Brinkhof, M. W. G., von Elm, E., Boldt, C., Brach, M., Fekete, C., & SwiSCI Study Group (2011). Design of the swiss spinal cord injury cohort study. *American Journal of Physical Medicine Rehabilitation/Association of Academic Physiatrists*, *90*(11 Suppl 2).

Quan, H., Li, B., Couris, C. M., Fushimi, K., Graham, P., Hider, P., & Sundararajan, V. (2011). Updating and validating the charlson comorbidity index and score for risk adjustment in hospital discharge abstracts using data from 6 countries. *American Journal of Epidemiology*, *173*(6), 676–682.

R Core Team (2014). *R: a language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing Retrieved from URL⟨http://www.R-project.org⟩.

Schuler, M. (2005). *Federal population census 2000*. Bern: Federal Statistical Office.

Sekhon, J. S. (2011). Multivariate and propensity score matching software with automated balance optimization: the matching package for R. *Journal of Statistical Software*, *42*, 7.

Smith, M. (2002). Efficacy of specialist versus non-specialist management of spinal cord injury within the UK. *Spinal Cord*, *40*(1), 10–16.

Swiss DRG AG, (2013). Regeln und Definitionen zur Fallabrechnung unter SwissDRG [Text]. Retrieved October 8, 2015, from: ⟨http://www.swissdrg.org/assets/pdf/Tarifdokumente/SwissDRG_Falldefinitionen_Version_5_2013_d_def.pdf⟩.

Swiss Federal Statistical Office, (1997). Der Datenschutz in der Medizinischen Statistik. Retrieved August 10, 2015, from: ⟨http://www.bfs.admin.ch/bfs/portal/de/index/infothek/erhebungen__quellen/blank/blank/mkh/02.Document.90754.pdf⟩.

Swiss Federal Statistical Office, (2010). Medstat-Regionen. Retrieved August 10, 2015, from: ⟨http://www.bfs.admin.ch/bfs/portal/de/index/infothek/nomenklaturen/blank/blank/medstat/02.html⟩.

Swiss Federal Statistical Office, (2012). Federal Hospital Discharge Statistics database. Retrieved August 10, 2015, from: ⟨http://www.bfs.admin.ch/bfs/portal/de/index/infothek/erhebungen__quellen/blank/blank/mkh/01.html⟩.

Tai, W. T. C., Porell, F. W., & Adams, E. K. (2004). Hospital choice of rural Medicare beneficiaries: patient, hospital attributes, and the patient–physician relationship. *Health Services Research*, *39*(6 Pt 1), 1903–1922.

Thomas, E., Symmons, D. P. M., Brewster, D. H., Black, R. J., & Macfarlane, G. J. (2003). National study of cause-specific mortality in rheumatoid arthritis, juvenile chronic arthritis, and other rheumatic conditions: a 20 year followup study. *The Journal of Rheumatology*, *30*(5), 958–965.

Vestergaard, P., & Mosekilde, L. (2002). Fracture risk in patients with celiac disease, Crohn's disease, and ulcerative colitis: a nationwide follow-up study of 16,416 patients in Denmark. *American Journal of Epidemiology*, *156*(1), 1–10.

Wahman, K., Nash, M., Westgren, N., Lewis, J., Seiger, A., & Levi, R. (2010). Cardiovascular disease risk factors in persons with paraplegia: the Stockholm spinal cord injury study. *Journal of Rehabilitation Medicine*, *42*(3), 272–278.

Welch, H. G., Larson, E. B., & Welch, W. P. (1993). Could distance be a proxy for severity-of-illness? A comparison of hospital costs in distant and local patients. *Health Services Research*, *28*(4), 441–458.

White, W. D., & Morrisey, M. A. (1998). Are patients traveling further? *International Journal of the Economics of Business*, *5*(2), 203–221.

Wickham, H. (2009). *ggplot2: elegant graphics for data analysis*. New York: Springer, Science & Business Media.

Wiedenhofer, D., & Keppler, S. (2014). Free hospital choice in Switzerland–patients' decision criteria and sources of information. *Interdisciplinary Management Research*, *10*, 763–773.

World Health Organization (2014). *WHO global disability action plan 2014–2021: better health for all people with disability*. Geneva, Switzerland: World Health Organization Retrieved from⟨http://www.who.int/disabilities/actionplan/en/⟩.

Wu, J. C., Chen, Y. C., Liu, L., Chen, T. J., Huang, W. C., Cheng, H., & Tung-Ping, S. (2012). Increased risk of stroke after spinal cord injury: a nationwide 4-year follow-up cohort study. *Neurology*, *78*(14), 1051–1057.