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Utilization of health care providers by individuals with chronic spinal cord injury

Armin Gemperli ^{1,2} · Mirjam Brach^{1,2} · Isabelle Debecker ³ · Inge Eriks-Hoogland ⁴ · Anke Scheel-Sailer ^{2,4} · Elias Ronca ^{1,2}

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Abstract

Study design Questionnaire survey conducted in 2017 as part of the Swiss Spinal Cord Injury Cohort Study (SwiSCI).
Objectives To elucidate the use of outpatient health care providers by individuals with chronic spinal cord injury in a situation of free choice and ample supply.
Setting Community, nationwide.
Methods The frequency of visits was compared to that of a survey conducted five years earlier. Using regression tree analysis, the characteristics of individuals with extensive use of health care providers' services were investigated. Substitution effects, where health care users replace one provider type by another, were quantified using likelihood ratios for positive outcomes.
Results The questionnaire was returned by 1,294 persons (response rate 33%). Participants reported visits to 14 different health care providers within the previous 12 months. Most often visited was the general practitioner (GP) by 82%. Older individuals used fewer health care providers than younger participants. Individuals with spasticity and females visited a broader variety of health care providers than the average user. The participants used fewer providers than they did five years ago. Health care users were not found to be substituting one provider type with another.
Conclusions Individuals with spinal cord injury in Switzerland use a wide array of medical service providers. All providers were used complementary to each other without redundancies between providers. The use of providers is driven by health-related factors and gender. Old age was not as much a driver for high utilization as described in other settings.

Introduction

Individuals with spinal cord injury (SCI) require a comprehensive array of care services for health maintenance and treatment of health conditions [1]. Specialized treatment facilities are generally considered the ideal setting for acute medical care and rehabilitation while for follow-up care, access to both specialized SCI care and general health care have been claimed to lead to better outcomes [2–4].

Specialized services offer the advantage of coordinated, integrated, multidisciplinary services “under one roof”, but are often centrally located with limited availability to those living in more remote areas [5, 6].

Switzerland offers a most suitable setting for studying the use of health care providers in a condition of free selection. The country offers a social insurance model with statutory compulsory, comprehensive health insurance for all its residents. All physicians can get reimbursed by the social health insurance. There are no defined cost-effectiveness thresholds and there is no gate-keeping, with direct access to specialized services. Health care supply is broad with 4.3 practicing doctors per 1000 population, as compared to 2.8 in the UK, 2.7 in Canada and 2.6 in the US [7]. There are 17.2 nurses per 1000 population, as compared to 11.7 in the US, 10.0 in Canada and 7.8 in the UK [7]. The average driving time to the nearest acute hospital is 6.5 min, 29.7 min to a university hospital [8]. By car, 98% of the population can reach a general hospital within 20 min, where almost all hospitals provide nearly all services [9]. There are four specialized SCI

✉ Armin Gemperli
armin.gemperli@paraplegie.ch

¹ Swiss Paraplegic Research, Nottwil, Switzerland
² Department of Health Sciences and Medicine, University of Lucerne, Lucerne, Switzerland
³ REHAB Basel, Clinic for Neurorehabilitation and Paraplegiology, Basel, Switzerland
⁴ Swiss Paraplegic Centre, Nottwil, Switzerland

centers accessible to all residents. Seventy-eight percent of individuals with SCI can reach a specialized treatment facility within 60 min by car, 36% within 30 min [10].

The objective of this study was to elucidate the use of outpatient health care providers for health maintenance and treatment of health conditions of individuals with chronic SCI in a situation of free choice and ample supply. The specific aims were to (1) describe the use of health care provision across a range of medical and therapeutic specialties during the last 12 months by individuals with SCI and to identify differences in provider utilization by subgroups; (2) describe the profile of persons with a high use of a broad range of providers with respect to their demographic and health-related attributes; (3) determine health care providers who were frequently substituted for other providers.

Methods

Study design

A paper questionnaire was sent to individuals with chronic SCI living in the community. Participants also had the option to fill out the survey online or participate in a telephone- or face-to-face interview. The nationwide survey was conducted between March 2017 and March 2018 within the framework of the Swiss Spinal Cord Injury Cohort Study (SwiSCI), subsequently referred to as Survey 2017. Study design and methodology are described elsewhere [11]. The SwiSCI community survey is conducted every 5 years, the first time in 2012 (subsequently referred to as Survey 2012), on the basis of the registries of four specialized SCI-rehabilitation centers, the national association for individuals with SCI, and a SCI-specific home care institution [12]. Unlike in the Survey 2017, where everyone was contacted, in the Survey 2012 the questionnaire on health care utilization was sent to only a random sample of one-third of the possible addressees. Eligible were individuals 16 years or older residing in Switzerland. Exclusion criteria were congenital conditions leading to SCI, neurodegenerative disorders or Guillain-Barré syndrome [11]. The study was approved by the Ethics Committee for the organizations that provided the contact addresses. All study participants signed an informed consent form. The study was based on a protocol that was approved by the SwiSCI steering committee before data were collected [13].

National setting

The costs of most of the provider types investigated were covered by the social health insurance, with the exceptions of dentists and dental hygienists. While some professionals (physicians, chiropractors, pharmacists) can directly bill the

health insurance, others require a referral, doctoral decree, or cooperation with a physician to do so. Therapies (speech-, occupational- or physical therapy, massage, and psychotherapy provided by psychologists) need to be prescribed by physicians to guarantee coverage by the social health insurance. The provider “alternative practitioner” was not further specified in the questionnaire, and refers to various, loosely regulated alternative and complementary providers whose services were mostly not paid for by the social health insurance (osteopathy, craniosacral therapy, Ayurveda, Feldenkrais method, aromatherapy, foot reflexology, shiatsu, reiki, etc.). Since 2017, five disciplines in complementary and alternative medicine are covered by the social health insurance when provided by a physician with specialist title and complementary medical education, namely homeopathy, anthroposophical medicine, neural therapy, phytotherapy, and traditional Chinese medicine. In Switzerland, chiropractic does not fall under complementary and alternative medicine.

Measures

Utilization of health care providers was investigated by asking about the frequency of visits to or from any health care provider in one of 14 different specialties (Table 1). A write-in space allowed participants to list additional providers.

Lesion characteristics such as para- or tetraplegia, completeness of lesion and time since SCI were derived from patient records, if available, or self-report. SCI etiology was collected by self-report. Complete paralysis was defined as no motor or sensory function preserved below the lesion level.

Demographic information collected was gender, age, years of education (adopted using items from the Model Disability Survey [14]), subjective social status from the McArthur scale [15], language (German, French, or Italian), birth country (Switzerland versus abroad), receiving professional home care, and whether the person lived alone. The geographical distribution of survey participants is described elsewhere [10].

General health status was investigated using the SF-12 [16]. The Rosenberg self-esteem scale [17] and the Purpose in life scale [18] were also used. The Life orientation test and General self-efficacy scale were adopted from the Model Disability Survey [14]. Self-reports of co-morbidities were extracted from the SCI secondary conditions scale [19]. A summary of all measures used in the SwiSCI survey is available on the SwiSCI webpage [20].

Statistical analysis

Demographic information and lesion characteristics were summarized with frequencies for categorical measures and

Table 1 Number of individuals visiting a health care provider.

Health care provider	Any visit within previous 12 months				Number of visits previous 12 months			
	Cross-sectional		Longitudinal		Cross-sectional		Longitudinal	
	Survey 2017 N = 1294 n (%)	Survey 2017 N = 221 n (%)	Survey 2012 N = 221 n (%)	Difference ^a N = 221 n (%)	Survey 2017 N = 1294 Mean (SD)	Survey 2017 N = 221 Mean (SD)	Survey 2012 N = 221 Mean (SD)	Difference ^a N = 221 Mean (SD)
General practitioner	1065 (82.3)	187 (84.6)	201 (91.0)	-6.3	3.6 (5.8)	3.1 (3.5)	5.4 (9.8)	-2.3
Specialist spinal cord injury	532 (41.1)	111 (50.2)	120 (54.3)	-4.1	0.9 (2.4)	1.0 (2.1)	1.2 (2.4)	-0.2
Specialist, other	659 (50.9)	119 (53.8)	-	-	2.3 (6.1)	2.0 (3.4)	-	-
Nurse or midwife	63 (4.9)	15 (6.8)	-	-	2.9 (29.5)	3.5 (34.7)	-	-
Dentist	802 (62.0)	153 (69.2)	180 (81.4)	-12.2	1.0 (1.4)	1.2 (1.5)	1.6 (1.7)	-0.4
Dental hygienist	641 (49.5)	121 (54.8)	140 (63.3)	-8.6	0.6 (0.8)	0.7 (0.8)	0.8 (0.7)	-0.1
Psychologist	108 (8.3)	16 (7.2)	32 (14.5)	-7.2	0.8 (4.6)	0.9 (5.1)	2.5 (10.7)	-1.7
Speech therapist	15 (1.2)	5 (2.3)	2 (0.9)	1.4	0.2 (3.7)	0.0 (0.4)	0.0 (0.2)	0
Occupational therapist	209 (16.2)	37 (16.7)	72 (32.6)	-15.8	2.9 (12.7)	2.4 (10.7)	4.1 (14.4)	-1.7
Physiotherapist	816 (63.1)	144 (65.2)	172 (77.8)	-12.7	28.0 (36.1)	28.6 (34.0)	32.5 (34.6)	-3.9
Massage therapist	237 (18.3)	51 (23.1)	61 (27.6)	-4.5	3.1 (10.3)	3.5 (10.9)	5.2 (14.5)	-1.7
Chiropractor	65 (5.0)	16 (7.2)	11 (5.0)	2.3	0.4 (3.0)	0.6 (4.1)	1.4 (13.8)	-0.8
Alternative practitioner	172 (13.3)	27 (12.2)	35 (15.8)	-3.6	1.3 (5.5)	0.9 (4.3)	1.5 (5.8)	-0.6
Pharmacist	488 (37.7)	90 (40.7)	-	-	3.5 (10.1)	4.3 (9.2)	-	-

SD standard deviation.

^aThe difference is computed for percentage and mean respectively as value of 2017 minus value of 2012.

mean and standard deviation for continuous measures. The frequency of participants with at least one visit during the last 12 months was computed by provider category, as well as the average number of visits by provider category, the latter including individuals who did not visit the provider in question. Subgroup specific numbers were calculated by gender, age, time since SCI, SCI etiology (traumatic or nontraumatic), para- or tetraplegia, and complete or incomplete paralysis and reported for subgroups with marked increased or reduced utilization of health care providers. Comparisons between subgroups were expressed as differences in percentages. ISCoS-recommended cutoffs were adopted to categorize age and years since injury [21].

The change in health care provider utilization between Survey 2017 and Survey 2012 was computed as differences in percentages and means. For the difference calculation only persons who participated in both surveys were included. Visits to the pharmacist and nursing services were not surveyed in 2012. Also, the division into medical specialties was different in the Survey 2012 and does not allow a 5-year comparison. The Survey 2012 did not ask about an umbrella “specialists” category but specifically listed some medical specialties.

Participants were flagged as extensive users of a category of health care provider if their number of visits during the

previous 12 months was above the median. We then counted those indicators across all health care provider categories and used the sum as an outcome in a regression tree analysis in order to identify subgroups with high utilization. The predictor variables used were gender, age, age at injury, time since SCI, lesion level and completeness, etiology, language, whether living alone or not, who provided support at home (formal and informal), birth outside of Switzerland, years of formal education, total household income, general health status, subjective social status, and all items from the following instruments: SCI secondary conditions scale, Life orientation test, General self-efficacy scale, Rosenberg self-esteem scale, and Purpose in life scale. Significance of subgroups was defined by pruning the tree. Optimal pruning was determined by minimal loss between predicted and actual outcome class verified by tenfold cross-validation [22].

To address the question whether health care provider types substitute for each other, we determined how much the non-use of a provider category predicts the use of another provider. This was computed using the likelihood ratio for positive results (LR+) which is the probability of using provider A when not using provider B, divided by the probability of using provider A when using provider B. LR + values >1 indicate a substitution effect, with values above 5 and 10 considered moderate and large, respectively [23].

Table 2 Demographics and lesion characteristics of the study population.

	Cross-sectional	Longitudinal study subgroup	
	Survey 2017 N = 1294	Survey 2017 N = 221	Survey 2012 N = 221
Sociodemographic characteristics			
Males – %	70.9	72.9	72.9
Age in years – Mean (SD)	56.4 (14.4)	59.9 (13.6)	54.4 (13.6)
Living alone – %	28.6	29.4	27.6
Having support by professional home care – %	21.6	21.7	18.6
Language – %			
German	71.1	69.7	71.0
French	24.2	25.8	24.9
Italian	4.7	4.5	4.1
Years of education – Mean (SD)	14.3 (3.5)	14.1 (3.4)	13.8 (3.0)
Lesion characteristics			
Tetraplegia – %	29.6	29.9	29.0
Complete lesion – %	36.1	41.7	40.7
Traumatic etiology – %	80.2	84.1	79.2
Time since SCI in years – Mean (SD)	18.8 (13.1)	23.2 (13.4)	17.8 (13.4)

SD standard deviation, SCI Spinal cord injury.

All analyses were descriptive, with all data without missing values in the analysis variables included. Data preparation and statistical analyses were conducted using Stata version 15.1 SE for Windows (College Station, TX, USA), and regression trees were computed with the rpart package within R [22].

Results

Out of 3959 eligible individuals, 1294 participated in this study (response rate 33%). Most were male (71%); the mean age was 56 years (Standard deviation (SD): 14 years), 19 years after injury on average (SD: 13 years) (Table 2). The study participants were mostly individuals with paraplegia (70% paraplegia), had an incomplete lesion (64%), and traumatic etiology (80%). The subset of 221 participants in the Survey 2017 who also participated in the Survey 2012 were 73% male, mean age of 60 years (SD: 14 years), 23 years after injury on average (SD: 13 years), with mostly paraplegia (70%), incomplete lesion (58%), and traumatic etiology (84%).

Eleven (1%) study participants reported not having used any health care provider during the previous 12 months. The most frequently visited provider was the general practitioner (GP), visited by 82%, followed by the physiotherapist (63%), and then the dentist (62%) (Table 1). The physiotherapist was most intensely visited (28 visits in 12 months, on average). Participants with tetraplegia were more likely to visit a physiotherapist (70%), occupational

therapist (26%), or nurse (8%) than participants with paraplegia (59%, 13%, and 4%, respectively).

Older individuals were less than average users of health care providers. Compared to the youngest participants, the oldest participants used all health care providers less often, except for the dentist (8% higher use rate in individuals aged 76 years or older as compared to individuals aged 30 years or younger). Individuals aged 76 years or older had a 34% reduced rate of visits to specialists in SCI, a 23% reduced rate of visits to physiotherapists and a 10% reduced rate of visits to psychologists, in comparison to individuals aged 30 years or younger. Nurses were visited by just 4% of the oldest age group as compared to 6% of the youngest age group, however, with 0.7 more visits by the oldest as compared to the youngest age group, on average in 12 months. In contrast to this, 30% of the participants in the oldest age group had professional home care, compared to 22% of those aged 30 years or younger, and with 36 more visits per year, on average. Individuals with a complete lesion had more visits to the SCI specialist than individuals with a motor or sensory incomplete lesion (51% vs 35%).

Providers not listed on the questionnaire but written in by participants were the osteopath (22 persons), and providers related to sports and fitness (12), foot care (6), and guided meditations (3).

The Survey 2012 was completed by 492 individuals of whom 221 also participated in the Survey 2017. Visits to all health care providers decreased in the five years between the surveys, except for the chiropractor (+2%) and the speech therapist (+1%) (Table 1). The largest reduction was observed for the occupational therapist (16% fewer patients who visited at least once), physiotherapist (13% fewer users) and dentist (12% fewer). The physiotherapist had the largest decline in number of visits (3.9 fewer visits per person, on average).

Two persons made visits to all 14 health care providers. The median number of different provider categories visited was five. Extensive use of health care providers was pronounced in participants who reported spasticity to be a significant or chronic problem (3.8 visits vs 3.0 for the non-spasticity cases) (Table 3). Within the group of persons with spasticity, females were extensive users of 4.6 different providers on average as compared to 3.5 providers used by males. Among the non-health-related predictors, female gender and more than 15 years of formal education (119 persons) were the most pronounced indicators of extensive use of health care providers with 3.9 different providers extensively used as compared to 3.2 in the entire sample.

The values of LR+ between all pairs of providers were all found to be around 1, with a maximal LR+ of 1.19, when predicting the use of speech therapy on the basis of the non-use of the dental hygienist.

Table 3 Subgroups with extensive use of health care providers.

Subgroup: Attribute with extensive use	<i>N</i>	Mean number of visits	Subgroup: Attribute without extensive use	<i>N</i>	Mean number of visits
————— Considering all attributes —————					
All participants	1294	3.2	All participants	1294	3.2
Spasticity	292	3.8	No spasticity	900	3.0
Females	86	4.6	No professional assistance at home ^a	779	2.9
————— Considering only non-medical attributes —————					
All participants	1294	3.2	All participants	1294	3.2
Females	376	3.6	Males	918	3.0
More than 15 years of education	119	3.9	Rosenberg Self-Esteem Scale: Sometimes I feel useless	330	2.6
Assistance by family member ^a	33	4.9			

Subgroups of extensive use were identified by means of a regression tree analysis. Subgroups were shown cumulatively; i.e., subgroups where nested within the subgroup from the row above.

Extensive use of a specific health care provider was defined as more than the median number of visits to a health care provider computed for all study participants within 12 months.

N Number of participants in the respective subgroup.

Mean number of visits: Mean number of different health care providers used extensively by the respective subgroup.

^aIndicate subgroups that were not significant using cross-validation.

Discussion

Use of health care provision

In Switzerland, where direct access to medical specialists exists, primary care providers remain the most frequently used providers by individuals with SCI. The rate of GP visits calculated was lower than in other western countries where the GP's referral is needed to access secondary care (Australia, Canada, UK), but higher than in the USA [24–26]. Besides GPs and medical specialists, health care users rely on an established system of rehabilitation providers such as physiotherapists and massage therapists. The comparison of Survey 2012 and Survey 2017 showed that visits to 9 out of 11 health care providers decreased over the last 5 years. A pattern of decrease has also been reported for hospitalizations between 2012 and 2017, implying that the reduction in outpatient visits was not compensated for by more inpatient hospitalizations [10, 27]. The reduction in health care utilization might be a result of improved living conditions, more intense preventive efforts or a changing culture with more empowerment of the individual. It remains to be studied if the decrease in utilization is at the expense of a long-term investment in health maintenance and results in poorer health.

In this study, neither social status nor any of the instruments to measure mental health were related to the use of the 14 categories of health care providers. This is in contrast to findings from research in other health systems,

where financial situation and mental health were identified as access barriers for persons with SCI [24, 28]. Old age was not found to be related to more use of health care providers and older individuals used fewer outpatient providers than younger individuals. This is counter to common notions of health care use and aging. However, some empirical work has demonstrated that variations in utilization are primarily caused by factors other than aging [29, 30]. Among persons with SCI, health care utilization was described to be increased in the first few years after initial rehabilitation, followed by a decline and a steady increase with older age [31].

Persons with high use of providers

Extensive use of health care providers was related to spasticity. Spasticity has been reported as one of the most common secondary health conditions after SCI [32, 33] and a common reason for rehospitalizations [34] and use of primary care services [26]. Spasticity has also been identified as a factor that impacts the content of treatment sessions [35]. Spasticity was the only health-related factor (secondary health conditions, perceived health status) identified. At least as important in extensive health care use were personal factors such as gender and education. In the literature, low education and female gender, were found to be related to an increase in secondary health conditions and health care utilization by people with SCI [36, 37] and in the general population [38]. In the SwiSCI survey, female gender was

associated with less utilization of specialized services and check-up visits [10]. This could be partly explained by the different treatment of sexual dysfunction for women and men. While women are more likely treated in primary care (GPs or gynecologists), men are more likely to visit the urology department at a specialized treatment facility. Also, screening visits for women (mammography, HPV/Pap smear) supposedly are more likely performed in general care while men use the annual check-up at the urology department of the specialized treatment facility for prostate screening. In some studies, higher education was found to prevent rehospitalizations, in other studies it was found to be not related [39]. Education was also not found to be related to whether individuals with SCI have a primary care provider or not [40]. Still, higher education has been linked to greater expectations towards the health system, explaining the higher health care utilization of individuals with more education in a situation of ample supply [28].

Mutually substituting providers

This study found that not visiting a certain category of health care provider does not increase the likelihood of a visit to another category of provider. Thus, the services provided were considered complementary and not substitutes for one another. All health care providers either satisfy a specific medical need with little overlap with other specialties, or they provide general services for individuals with diverse health needs not specific to their medical specialty.

Strengths and limitations of this study

Strengths of the study were its broad, nationwide sampling frame and a sample size of 1294 participants in the Survey 2017. However, for the longitudinal comparison only 221 of the 492 participants in the Survey 2012 (45%) participated again in the Survey 2017. Those that were lost to follow-up, from 2012 to 2017, were likely not a random selection, resulting in a bias of unknown direction and size relative to the target population. In the absence of a national SCI registry, centralized medical records or electronic patient records, it is not possible to gauge the coverage achieved in our sampling efforts and the sample's representativeness of the general SCI population. The invited population was found to be biased towards men, younger persons and individuals with high tetraplegia [41]. Investigations of the survey response suggest a negligible bias caused by non-response [11, 12].

Further issues with respect to self-reporting are recall bias and a non-standardized perception of health care services by the study participants. Self-reports on health care utilization have been found to rather under-estimate

utilization in comparison to counts based on medical records, by a magnitude of up to 70% [42]. The survey reported on health care services as perceived by participants, not how health care provision was defined by the health system. This might allow for to contradictory perceptions relating to providers offering physical therapy, such as sports therapy, massage or physiotherapy, or relating to service providers grouped under "alternative practitioner". E.g., some participants may categorize osteopaths as alternative practitioners, while for others they might fall under physical therapy.

The choice of health care services depends on the availability of relevant information. While a few quality indicators for inpatient services are systematically collected and published in Switzerland, these are completely lacking in the outpatient sector. It is unclear to what extent this lack of transparency might influence the patient's choice of health care providers [43].

Conclusion

In a health system like Switzerland's with ample choice and no gate-keeping, individuals with SCI use a wide array of providers for check-ups and treatment of health conditions. Despite strong reliance on specialized services and direct access to specialists, the GP is the provider visited by most persons. There is no substitution effect between providers. Hence, even in a situation of ample supply, no substitution takes place. The use of health care providers is driven by health-related and gender. Old age neither triggers more nor different provider utilization.

Data Archiving

Owing to our commitment to SwiSCI study participants and their privacy, datasets generated during the current study are not made publicly available but can be provided by the SwiSCI Study Center based on reasonable request (contact@swisci.ch).

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Author contributions All authors were responsible for the conceptualization of the analysis. AG and ER were responsible for the data analysis. All authors were responsible for the interpretation and framing of the findings. AG wrote the first draft of the manuscript and all authors worked on, reviewed and approved the final version of the manuscript.

Compliance with ethical standards

Statement of ethics Ethical approval for Survey 2012 was approved by the principal ethics committee on research involving humans of the Canton of Lucerne (KEK Luzern, internal application 11042, approved 28.06.2011) and subsequently endorsed by the additional involved cantonal ethics committees of the Cantons of Basel-Stadt (EK Basel, internal application 306/11, approved 06.09.2011) and Valais (CCVEM Sion, internal application CCVEM042/11, approved 06.12.2011). Ethical approval for Survey 2017 was granted by the leading ethical institution Ethikkommission Nordwest-und Zentralschweiz (EKNZ, Project-ID: 11042 PB_2016-02608, approved Dec 2016). We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research.

Conflict of interest The authors declare that they have no conflict of interest.

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References

- Gemperli A, Ronca E, Scheel-Sailer A, Koch HG, Brach M, Trezzini B. Health care utilization in persons with spinal cord injury: part 1—outpatient services. *Spinal Cord*. 2017;55:823–7. Sep.
- New PW. Non-traumatic spinal cord injury: what is the ideal setting for rehabilitation? *Aust Health Rev Publ Aust Hosp Assoc*. 2006;30:353–61. Aug.
- Cox RJ, Amsters DI, Pershouse KJ. The need for a multi-disciplinary outreach service for people with spinal cord injury living in the community. *Clin Rehabil*. 2001;15:600–6. Dec.
- Bickenbach J, International Spinal Cord Society, World Health Organization. *International perspectives on spinal cord injury*. Geneva, Switzerland: World Health Organization; 2013.
- Illis LS. The case for specialist units. *Spinal Cord*. 2004;42:443–6. Aug.
- Ronca E, Scheel-Sailer A, Koch HG, Essig S, Brach M, Münzel N, et al. Satisfaction with access and quality of healthcare services for people with spinal cord injury living in the community. *J Spinal Cord Med*. 2020;43:111–21. Jan.
- Organisation for Economic Co-operation and Development. *Health at a glance 2019: OECD indicators*. [Internet]. Paris: OECD Publishing; 2019. <https://doi.org/10.1787/4dd50c09-en>.
- Berlin C, Panczak R, Hasler R, Zwahlen M. Do acute myocardial infarction and stroke mortality vary by distance to hospitals in Switzerland? Results from the Swiss National Cohort Study. *BMJ Open*. 2016;6:e013090. Nov.
- Credit Suisse. *Gesundheitswesen Schweiz 2013: Der Spitalmarkt im Wandel [in German]*. Credit Suisse; 2013.
- Ronca E, Scheel-Sailer A, Eriks-Hoogland I, Brach M, Debecker I, Gemperli A. Factors influencing specialized health care utilization in individuals with spinal cord injury: a cross-sectional survey. *Spinal Cord*. 2020. <https://doi.org/10.1038/s41393-020-00581-6>.
- Gross-Hemmi MH, Gemperli A, Fekete C, Brach M, Schwegler U, Stucki G. Methodology and study population of the second Swiss national community survey of functioning after spinal cord injury. *Spinal Cord*. 2020. <https://doi.org/10.1038/s41393-020-00584-3>.
- Brinkhof MWG, Fekete C, Chamberlain JD, Post MWM, Gemperli A. Swiss national community survey on functioning after spinal cord injury: protocol, characteristics of participants and determinants of non-response. *J Rehabil Med*. 2016;48:120–30. SwiSCI Study GroupFeb.
- Post MWM, Brinkhof MWG, von Elm E, Boldt C, Brach M, Fekete C, et al. Design of the Swiss spinal cord injury cohort study. *Am J Phys Med Rehabil*. 2011;90:S5–16. Nov.
- Cieza A, Sabariego C, Bickenbach J, Chatterji S. Rethinking disability. *BMC Med*. 2018;26:16–14.
- Goodman E, Adler NE, Kawachi I, Frazier AL, Huang B, Colditz GA. Adolescents' perceptions of social status: development and evaluation of a new indicator. *Pediatrics*. 2001;108:E31. Aug.
- Ware JE, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care*. 1992;30:473–83. Jun.
- Rosenberg M. *Society and the adolescent self-image*. Princeton NJ, Princeton University Press; 1965.
- Schulenberg SE, Schnetzer LW, Buchanan EM. The purpose in life test-short form: development and psychometric support. *J Happiness Stud*. 2011;12:861–76. Oct 1.
- Kalpakjian CZ, Scelza WM, Forchheimer MB, Toussaint LL. Preliminary reliability and validity of a Spinal Cord Injury Secondary Conditions Scale. *J Spinal Cord Med*. 2007;30:131–9.
- Swiss Spinal Cord Injury Cohort Study—Reference Questionnaires of Community Survey [Internet]. <https://swisci.ch/en/research-projects-home/study-design/community-survey>.
- Hinrichs T, Proding B, Brinkhof MWG, Gemperli A. SwiSCI study group. Subgroups in epidemiological studies on spinal cord injury: evaluation of international recommendations in the Swiss Spinal Cord Injury Cohort Study. *J Rehabil Med*. 2016 Feb;48:141–8.
- Themeau TM, Atkinson EJ. Introduction to recursive partitioning using the RPART routines [Internet]. Mayo Foundation; 2019. <https://cran.r-project.org/web/packages/rpart/vignettes/longintro.pdf>.
- McGee S. Simplifying likelihood ratios. *J Gen Intern Med*. 2002;17:647–50. Aug.
- Borg DN, Foster MM, Legg M, Jones R, Kendall E, Fleming J, et al. The effect of health service use, unmet need, and service obstacles on quality of life and psychological well-being in the first year after discharge from spinal cord injury rehabilitation. *Arch Phys Med Rehabil*. 2020;101:1162–9. Jul.
- Donnelly C, McColl MA, Charlifue S, Glass C, O'Brien P, Savic G, et al. Utilization, access and satisfaction with primary care among people with spinal cord injuries: a comparison of three countries. *Spinal Cord*. 2007;45:25–36. Jan.
- McColl MA, Aiken A, McColl A, Sakakibara B, Smith K. Primary care of people with spinal cord injury: scoping review. *Can Fam Physician Med Fam Can*. 2012;58:1207–16. Nov e626-635.
- Ronca E, Scheel-Sailer A, Koch HG, Gemperli A. Health care utilization in persons with spinal cord injury: part 2—determinants, geographic variation and comparison with the general population. *Spinal Cord*. 2017;55:828–33. Sep.
- McColl MA, Jarzynowska A, Shortt SED. Unmet health care needs of people with disabilities: population level evidence. *Disabil Soc*. 2010;25:205–18. Mar 1.
- World Health Organization. *World report on ageing and health*. Geneva, Switzerland: World Health Organization; 2015.

30. Reinhardt UE. Does the aging of the population really drive the demand for health care? *Health Aff.* 2003;22:27–39. Nov 1.
31. Dryden DM, Saunders LD, Rowe BH, May LA, Yiannakoulis N, Svenson LW, et al. Utilization of health services following spinal cord injury: a 6-year follow-up study. *Spinal Cord.* 2004;42:513–25. Sep.
32. Hitzig SL, Tonack M, Campbell KA, McGillivray CF, Boschen KA, Richards K, et al. Secondary health complications in an aging Canadian spinal cord injury sample. *Am J Phys Med Rehabil.* 2008;87:545–55. Jul.
33. Noreau L, Proulx P, Gagnon L, Drolet M, Laramée MT. Secondary impairments after spinal cord injury: a population-based study. *Am J Phys Med Rehabil.* 2000;79:526–35. Dec.
34. Paker N, Soy D, Kesiktaş N, Nur Bardak A, Erbil M, Ersoy S, et al. Reasons for rehospitalization in patients with spinal cord injury: 5 years' experience. *Int J Rehabil Res Int Z Rehabil Rev Int Rech Readaptation.* 2006;29:71–6. Mar.
35. Dijkers MP, Zanca JM. Factors complicating treatment sessions in spinal cord injury rehabilitation: nature, frequency, and consequences. *Arch Phys Med Rehabil.* 2013;94:S115–124. Apr.
36. Munce SEP, Guilcher SJT, Couris CM, Fung K, Craven BC, Verrier M, et al. Physician utilization among adults with traumatic spinal cord injury in Ontario: a population-based study. *Spinal Cord.* 2009;47:470–6. Jun.
37. Klotz R, Joseph PA, Ravaud JF, Wiart L, Barat M. Tetrafigap Group. The Tetrafigap Survey on the long-term outcome of tetraplegic spinal cord injured persons: Part III. Medical complications and associated factors. *Spinal Cord.* 2002;40:457–67. Sep.
38. National Academies of Sciences. Factors that affect health-care utilization [Internet]. Health-care utilization as a proxy in disability determination. National Academies Press (US); 2018. <https://www.ncbi.nlm.nih.gov/books/NBK500097/>.
39. Wineman NM, Leffler E, Radziewicz RM, Sams C. A comparative analysis of individuals with spinal cord injury who differ in unplanned utilization of health services. *SCI Nurs Publ Am Assoc Spinal Cord Inj Nurses.* 1999;16:42–7. Jun.
40. Harrington AL, Hirsch MA, Hammond FM, Norton HJ, Bockenek WL. Assessment of primary care services and perceived barriers to care in persons with disabilities. *Am J Phys Med Rehabil.* 2009;88:852–63. Oct.
41. Chamberlain JD, Ronca E, Brinkhof MWG. Estimating the incidence of traumatic spinal cord injuries in Switzerland: using administrative data to identify potential coverage error in a cohort study. *Swiss Med Wkly.* Accessed 13 Mar 2017.
42. Hunger M, Schwarzkopf L, Heier M, Peters A, Holle R. KORA Study Group. Official statistics and claims data records indicate non-response and recall bias within survey-based estimates of health care utilization in the older population. *BMC Health Serv Res.* 2013;13:1.
43. Vincent C, Staines A. Enhancing the quality and safety of Swiss healthcare [Internet]. 2019. (A national report commissioned by the Federal Office of Public Health on the quality and safety of healthcare in Switzerland). <https://www.bag.admin.ch/dam/bag/en/dokumente/kuv-leistungen/qualitaetssicherung/verbesserung-der-qualitaet-und-patientensicherheit-des-schweizerischen-gesundheit.pdf.download.pdf/Enhancing%20the%20Quality%20and%20Safety%20of%20Swiss%20Healthcare-EN.pdf>.