

Factors that prolong hospitalization of patients with spinal cord injury

Fotopoulou S, Benetos IS, Pneumáticos S, Vlamis J

3rd Department of Orthopaedic Surgery, University of Athens, KAT Hospital, Athens, Greece

ABSTRACT

Spinal cord injury (SCI) is a severe condition which can cause damage to the sensation as well as to the motor function of the individual. Many factors have been reported to affect the length of stay (LOS) of the SCI patient in the hospital or the rehabilitation center. These factors vary among different countries, and therefore the LOS also varies. The purpose of this review is to investigate the existing literature to detect factors which may prolong hospitalization of patients with SCI. Identifying these parameters can help minimize the length of hospital stay as well as the costs and also complete rehabilitation within a required period of time. The 40 studies that were included manifested that demographic factors such as age, gender and marital status did not seem to contribute to extended hospitalization whereas both severity and etiology of injury and secondary medical complications were significantly associated with longer LOS. Moreover, prolonged length of stay of SCI patients has been associated with hospital determinants, e.g. the institutional facility and the insurance status of the patient. However, since the studies that investigate the role of hospital factors on LOS are few, more studies are required on this subject in the future.

KEY WORDS: SCI, hospitalization, rehabilitation, length of stay

Introduction

Spinal cord injury (SCI) is a devastating condition that can cause damage or loss of sensation and motor function, as well as dysfunction of multiple organs [1]. It can also lead to functional, psychological and socioeconomic disorder [2]. The annual incidence of SCI in various countries varies. More specifically, the incidence rates of SCI in the developed countries range from 13,1 to 163,4 [3-4] per million people, with similar rates in developing countries (13,0 to 220,0 [5-6] per million people). In Greece the incidence rates are 33.6 per million people [7]. Also, the causes of these injuries vary, with some of the most common being motor vehicle accidents, falls, sports-related injuries, violence related injuries and occupational injuries [8].

There are many factors affecting the length of stay in patients with SCI, which varies among different countries due

to medical issues and/or the country's health care system. It has been reported that the median number of hospitalization of SCI patients in Australia is 133 days, in United States 20-74 days, in Italy 91-143 days, in the Netherlands 154 days, in Spain 198-222 days, in Denmark 149-285 days and in Israel 239 days [9-11]. It is understood that a prolonged hospital stay for patients with SCI can impose great burden both to the individual and the health-care system [12]. It was estimated that the direct cost of a patient with spinal cord injury was \$85 565 288.00 [13]. Therefore, it is important to identify and understand the factors that affect long of stay in hospital for these patients.

According to the literature, the determinants that may prolong hospitalization for spinal cord injury patients are classified as either personal or factors mainly related to the hospital [14, 15]. The personal factors include age, severity

CORRESPONDING
AUTHOR,
GUARANTOR

Fotopoulou S: 3rd Department of Orthopaedic Surgery,
University of Athens, KAT Hospital, Athens, Greece,
Email: sfotop81@gmail.com

of injury, degree of disability on admission, marital status, other demographic factors as well as the development of secondary medical complications mainly urinary tract infections, respiratory infections, and pressure sores [16], whereas hospital factors comprise the type of the institution (public or private), the availability of beds and staffing levels [17].

Most of the patients with spinal cord injuries receive rehabilitation after their discharge from the hospital, to address the impact of their injuries, since rehabilitation aims to help patients' restore range of activities and active participation in all aspects of human life, maximize independence and prevent further complications. Rehabilitation can also enhance patients' emotional adaptation as well as promote reintegration into the community [18]. Early rehabilitation of SCI in an organized multidisciplinary care system has been shown to be beneficial, as it offers lower mortality, reduced pressure ulcers, slightly greater chances of neurological recovery and shorter length of stay which therefore results to lower hospital costs [19].

The aim of this study is to review the existing literature to detect factors which may prolong hospitalization of patients with spinal cord injuries. Identifying these parameters can help minimize the length of hospital stay and also complete rehabilitation within required period of time.

For this purpose a literature review was conducted in a scientific publication resource, the MEDLINE (PubMed) (<https://www.ncbi.nlm.nih.gov/pubmed>). Temporal criteria were applied in order to access the literature of the last 30 years (from 1987 to 2020). In the research were included only articles published in English language. The keywords applied regarded spinal cord injury, prolonged hospitalization, and length of stay. The search of the databases returned 6315 articles. Publications that did not match the research criteria were excluded from the study. The final number of articles were 40.

Discussion

According to Post et al., the term length of stay (LOS) is determined as the time between the first admission and the final discharge from the hospital or other health care facility [20].

Our search revealed 40 papers that were relevant with this topic.

Of these included studies, 34 investigated the personal factors that affect LOS of patients with spinal cord injuries while 6 studies analyzed the connection between hospital

factors and LOS in these patients.

As far as personal factors are concerned, the main determinants according to the included studies are age, gender, and marital status of the subject, as well as the presence of medical complications, the severity and the etiology of the injury [15].

There are many studies that have demonstrated that the patient's age plays an important role in the length of stay following SCI. In more detail, a study that included 284 patients with SCI, showed that older patients tended to have shorter LOS in comparison to younger patients [21]. However, in this study older SCI patients also had more complications and therefore worse outcome in comparison to younger patient group of the survey. Moreover, in a study conducted by Roth et al., the results were similar with the above mentioned [22]. A recent study that investigated several predictors of 529 patients with SCI, demonstrated that age, among others, was a significant factor [23]. The authors showed that younger patients (≤ 45 years old) had longer LOS. These results were also confirmed by another study on patients with traumatic spinal cord injuries [24].

However, the results of other studies were contradictory. A large scale study showed that no significant differences were found between LOS and age, however rehabilitation time were greater for older patients [25]. De Vivo et al., conducted a large scale study investigating SCI patients over a period of 13 years [26]. The authors concluded that age was not a risk factor that prolonged hospitalization. There are additional studies, also verifying these results [10, 11, 27-31].

Another demographic characteristic that may affect hospitalization is gender. An early study conducted in SCI patients in Saudi Arabia showed that male patients with SCI were more prone to have longer LOS in comparison to female patients [28]. Contrariwise, Ronen et al., concluded that male SCI patients did not have statistically greater LOS when compared to female patients [11]. Similarly, an earlier multi-center study examining the correlation of gender and rehabilitation LOS demonstrated no statistically significant association between gender and LOS in patients with spinal cord injury [32]. Also, Milicevic et al., in their study reported that gender was not associated with longer LOS of SCI patients [23]. A similar study that took place in Ankara, Turkey reported that gender was not a significant predictor for prolonged hospitalization [29]. Despite the above, there have been studies that concluded that demographic factors such as age and gender are not statistically significant deter-

minants of LOS in these patients [10, 30].

Marital status is also another demographic factor that has been investigated as a possible predictor of prolonged stay in SCI patients. Specifically, Go, DeVivo and Richards reported that more than 50% of SCI patients in their study were single at the time of the injury, while 30% were married [33]. A later longitudinal prospective study demonstrated that no statistical significance between the marital status of patients and LOS was detected [34]. However, we must emphasize that most of the patients included in this study were married. Norton, in his study, reported that 45% of SCI patients in Australia were either married or in a serious relationship [9].

There are also studies that underline the importance of the severity of the injury in LOS. Specifically, Pompei et al., found a great correlation between the severity of injury and LOS, in patients with spinal cord injury [35]. Many studies also confirmed these results. A study that investigated the role of complications in 191 patients with SCI showed that the more severe the injury of the spinal cord and the vertebral column, the greater the LOS [30]. Similarly, in a study that investigated whether hemoglobin and albumin could be used as predictors of LOS in spinal cord injured patients, it was shown that patients with more severe injuries also had longer LOS [36]. Additionally, a study that included 1367 patients with spinal cord injuries demonstrated that the severity of the injury was statistically associated with higher LOS [11]. Al-Jadid et al., (2010) conducted a retrospective study in Saudi Arabia that verified the above mentioned results [28]. In a similar study conducted in Turkey, the researchers showed that patients with tetraplegia had longer length of stay in comparison to paraplegic patients [29]. Another study also confirmed the above mentioned results [37]. Moreover, Norton, states that severity of injury can be used as a predictor of prolonged hospitalization for SCI patients [9]. Also, another study concluded that SCI patients with complete injuries were more prone to prolonged stay in health facilities in comparison to those with incomplete injuries [38]. The results of a retrospective study that took place in Serbia were in accordance with the results of the other studies presented here [23]. However, a study conducted in patients with spinal cord injury in Korea revealed no correlation between the severity of the injury and LOS. Therefore, the researchers concluded that other factors, mainly socio-psychological, prolonged hospitalization in these SCI patients [10].

The etiology of injury is another factor that may affect hospitalization length in patients with spinal cord injury.

Ronen et al., concluded that SCI etiology was correlated with LOS [11]. The authors showed that patients with traumatic SCI presented a statistically significant greater LOS in comparison to patients with non-traumatic SCI. A multicenter retrospective study that included 859 SCI patients also demonstrated that patients with traumatic spinal cord injuries had longer LOS than non-traumatic ones [39]. Other studies also confirmed these results [40, 41]. Also, Al-Jadid et al., manifested that non-traumatic SCI patients had much shorter LOS than traumatic SCI patients regardless the age [28]. Similar results were reported from a Turkish study [29]. The findings of another study that compared LOS of patients with traumatic and non-traumatic spinal cord injuries support the fact that the first have longer length of stay than the second ones [42]. Jang et al., demonstrated that patients with traumatic SCI stayed longer in health facilities [10]. Specifically, they reported that SCI traumatic patients, due to motor accidents, had longer LOS compared with SCI patients due to other causes. Yet, there is a study that reports that although patients with traumatic SCI have more severe lesions and therefore more problems and complications, no statistical significance was revealed between etiology and LOS [43].

Additionally, it is quite common for patients with spinal cord injury to present medical complications during or after the acute phase of injury [44]. According to the literature, the most frequent complications include pressure sores and infections such as urinary and respiratory tract complications [45, 46].

It has been estimated that 17% to 33% of patients with SCI will develop pressure ulcers [47]. A study conducted on SCI veterans showed that the majority of the patients would develop pressure sores during the first year of the injury, no matter the treatment that was used [47]. Also, the same study reported that a predictor for the development of pressure ulcers was the longer sitting time at discharge, showing the importance of early mobilization in these patients. An earlier retrospective study that included 176 SCI veteran patients, also confirmed the above mentioned results as it demonstrated that 35% of these patients had a recurrent pressure sore [48]. Moreover, Milicevic et al., also confirmed that SCI patients that developed pressure ulcers had a significant longer LOS [23]. A study conducted in Italy showed that pressure ulcers were the major complication in patients with SCI and therefore a factor for longer hospitalization [24]. Similarly, other studies also demonstrated similar results [39,49,50]. In a study investigating the prevalence of

pressure ulcers in SCI patients in the United Kingdom, the authors demonstrated that this secondary complication was a strong predictor of longer hospitalization. Moreover, in the same study it was shown that when a patient developed a pressure sore, then his stay at the hospital was prolonged by 55 days [51]. A retrospective five year survey showed that LOS for SCI patients with pressure ulcers was longer than those that did not have this specific complication [52]. A much earlier study also demonstrated that LOS of SCI patients with pelvic pressure ulcers was significantly greater compared to patients with non pelvic pressure ulcers or no pressure ulcers at all [53].

Urinary tract infections (UTI) occur often in patients with spinal cord injuries, prolonging their length of stay [54]. It has been estimated that more 60% of SCI patients will develop a urinary tract infection at some point [55]. A prospective follow-up study that included 128 patients with spinal cord injury showed that these patients were at greater risk of developing UTI, leading to prolonged hospitalization [56]. Another study, reported that the use of catheterization for a period of time greater than five years can cause injuries at the urethra and therefore, in some cases, UTI [57]. Moreover, it has been established that UTI can also develop in SCI patients that are under catheterization [58]. A retrospective study have shown that patients developing UTI stay longer in the hospital and/or rehabilitation center in comparison to patients that do not show any secondary complication [23]. Chu et al., in a nationwide study conducted in Taiwan, reported similar results [49]. Also, a later conducted study in Tianjin, China with 631 SCI patients demonstrated that patients with urinary tract infections had significant longer LOS [50]. In addition to the above, a study that investigated the role of complications and the costs in patients with spinal cord injury demonstrated as well that patients with UTIs had longer LOS [30].

Another complication that occurs often in patients with spinal cord injury concerns the respiratory tract [59, 60]. It has been estimated that the prevalence rates concerning this complication in SCI patients are between 36% to 83% [61]. It can prolong the length of stay either at the hospital or at the rehabilitation center. As it has been described, the development of respiratory complications has been linked with the severity of the injury [62]. In a study that investigated the incidence of respiratory problems in 46 SCI patients, it was shown that pneumonia (63%) was the most common complication [63]. Moreover, the same study showed that, depend-

ing on the type of injury, the patients develop different complication of the respiratory tract. A multicenter study that also investigated the incidence of respiratory complications in SCI patients showed that the most common complication was atelectasia followed by ventilatory failure, pleural effusion, and pneumothorax or hemothorax [64]. A later study that examined the lifetime risks for three diseases outcomes, including spinal cord injuries, demonstrated a direct correlation between tetraplegia and respiratory infections, showing that these patients were more prone in developing complications in the respiratory tract [65]. Also, a retrospective study conducted from 1993-1997 showed that SCI patients that developed respiratory complications had longer LOS [66]. The scientists concluded that the respiratory complications were a more important factor of LOS in comparison to severity of injury. Moreover, Post et al., in their study, concluded that pulmonary infections are an important predictor of prolonged stay for SCI patients [20]. Tator et al. showed that respiratory complications increase not only patients' LOS but also the overall cost of stay [8]. Yet, another survey studying the factors affecting LOS in SCI patients in China showed that patients with respiratory complications and infections did not have longer LOS [50].

The hospital determinants that affect LOS of SCI patients include hospital facilities as well as the type of the institution (private or public) [17]. The results regarding the facilities of the hospital are contradictory. Specifically, there are studies reporting that LOS in larger hospitals, with more beds and facilities is longer [67] while others support the exact opposite, meaning shorter LOS for these patients [14].

Moreover, another study regarding the impact of public or private insurance showed that the LOS of patients in public hospitals were longer comparing to private ones [68]. A study conducted in China investigated the factors that affected LOS in 631 SCI patients, including not only demographic and personal determinants, but also hospital determinants as well [50]. The researchers showed that when hospital factors were examined, the location of the hospital was a statistical significant predictor of LOS. More specifically, it was demonstrated that hospitalization in a suburban hospital increases LOS. A recent study aiming to specify factors that determined LOS in patients with spinal cord injury, demonstrated that the healthcare system organization and processes affected LOS of these patients, regardless of patients' demographics [69].

In some cases, it has also been reported that prolonged

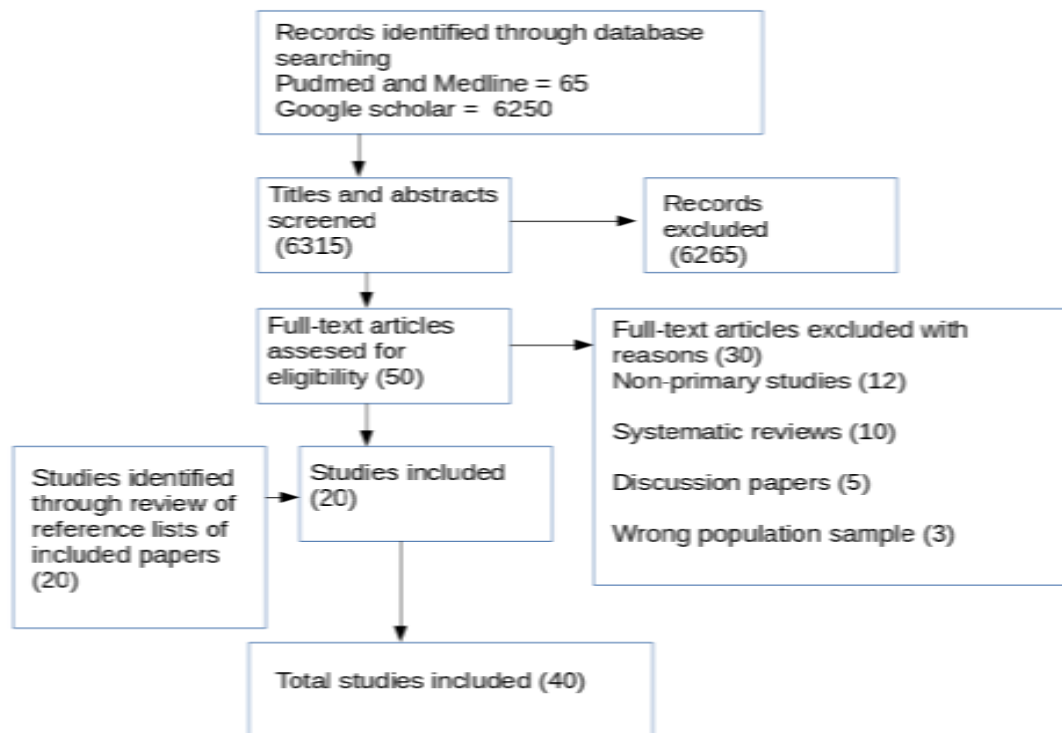


Table 1: Flowchart

hospitalization was due to medical doctors' workload [70]. Nevertheless, literature data is insufficient to support such conclusion.

In our review, we investigated the factors that may prolong the length of stay of SCI patients in health care facilities, such as hospitals and rehabilitation centers. According to the literature, these factors are categorized either as personal factors (age, gender, marital status, secondary complications etc.) or hospital factors (hospital facilities, private or public health care facilities, the health care system of each country etc.).

As far as the age of the patient is concerned the results were contradictory since there were studies that demonstrated that age was a significant factor that determined LOS [21-23] and others that concluded that age did not affect the length of stay of these patients [8, 10, 11, 25-29, 31]. It has been reported that the majority of individuals that are affected by spinal cord injuries belong to younger age groups [71]. This can be explained by the fact that younger individuals are more active, therefore they have greater risk for injuries, including spinal cord injuries. However, age did not seem to cause prolonged hospitalization in the majority of the stud-

ies included, meaning that age is not considered a strong predictor of prolonged stay in SCI patients.

Also, gender was another factor that was investigated as a possible determinant of prolonged hospitalization. Similarly, with age our research for gender revealed contradictory results as well. Yet the majority of the studies concluded that gender did not affect LOS [10, 11, 23, 29, 30, 32]. It has been reported that SCI incidence is four times more frequent in males than in females [72]. This was also the case for the most of studies included in this review. This high incidence can be due to the fact that men, in majority, are more physically active and more engaged in outdoor activities therefore they have greater risk for a spinal cord injury in comparison to females. Although, most of the studies presented a higher male proportion than female, the statistical analysis did not reveal an association between gender and LOS in SCI patients.

Only few studies investigated the role of marital status in prolonged hospitalization of SCI patients [9,33,34]. Although 45% of patients with spinal cord injury are married or in serious relationship, no statistically significant connection was found between these two factors.

Socioeconomic factors also have been identified as a possible factor that affects hospitalization. Another prospective study investigated the role of income, education and occupation in the LOS, showing that patients with lower incomes have longer LOS [73]. A similar study conducted in Jordan showed that socioeconomic factors can affect the length of hospitalization of patients with SCI [14]. In more detail, in this study patients with high socioeconomic status were more prone to have shorter LOS when compared to patients from lower socioeconomic levels. Still, since the studies that investigated these factors are few, more quality studies are needed in order to come to safer conclusions.

The severity of the injury was also investigated in many studies included in our review. All of the included studies underlined the fact that as the severity of the injury increased so did the length of stay of the patients. It was demonstrated that patients with tetraplegia had longer LOS than patients with paraplegia. This can be explained by the fact that quadriplegic patients have more severe injuries and therefore can have more complications than paraplegic patients. Additionally, it has been reported that although injury severity is significantly linked to extended LOS, there are also other factors that present much stronger associations [74]. In more details, physiologic status, and body region injured play also an important role to LOS. Only one study showed no correlation between severity and LOS of SCI patients [10]. This can be due to the relatively small number of patients included in that study.

Several authors have assessed the etiology of SCI and its role in LOS. All studies demonstrated that traumatic SCI patients have significantly greater LOS compared to non-traumatic patients. However, there was one study concluding that, despite the higher severity of lesions of traumatic SCI patients, no statistical significance was revealed [43]. The drawback of this survey was that they included a small sample of SCI patients (67 patients).

Furthermore, another study that aimed to determine the role of surgical complications, showed that secondary complications lead to longer length of stay [75]. Specifically, the development of pressure ulcers is quite common in patients with SCI. Many researchers have studied the role that these complications play to LOS following spinal cord injuries. All studies came to the conclusion that pressure ulcers were strong predictors of prolonged hospitalization. A review that investigated pressure ulcers in SCI patients in developed countries manifested that SCI-associated pres-

sure ulcers are frequent and can increase the healthcare costs [76,77]. Furthermore, they are associated with rehabilitation problems, which might lead to a worse functional outcome [47].

Another significant factor of morbidity and mortality that is often seen in SCI is respiratory infections [59]. According to the level of the lesion, SCI patients may demonstrate inadequate breathing and/or coughing capacity, thus becoming more prone to respiratory infections [78,79]. The studies included in this review demonstrated that respiratory complications can lead to increased stay at the health centre [80].

Urinary tract infections (UTIs) are predominant secondary complications in patients with SCI and represent one of the main reasons for seeking medical advice [12, 81]. They are mainly due to the frequent use of a catheter, due to bladder dysfunctions [81]. All studies examining the impact of UTIs in LOS demonstrated an important association between those two factors. In more details, it was shown that patients that developed a UTI had stayed significantly longer in the health facility in comparison to SCI patients that did not develop UTI.

According to O'Keefe et al., clinical factors alone represent only 27% of the variation in extended LOS [82]. Prolonged length of stay of SCI patients has been associated with hospital determinants. A study conducted in Turkey, investigated the length of stay in university hospitals [83]. The factors that determined prolonged LOS in this study were the institutional facility as well as the insurance status of the patient. Also, other researchers in a similar study conducted in Jordan, showed that the insurance status of the patient was a strong predictor of LOS [14]. Specifically, patients with insurance had significant longer LOS. Another cross sectional survey that studied hospital stay of the Dutch health care system concluded that inappropriate hospital stay was linked to the lack of health care facilities as well as the lack of appropriate discharge facilities [84].

A retrospective review that examined the factors affecting hospital discharge of SCI patients showed that four factors were significantly related [85]. These factors were the age of the patient, the preinjury living conditions, the insurance status as well as the private funding for specialized assisting equipments. Therefore, it is advised that these factors should be taken into account before discharging an individual with SCI in the community. Another retrospective study investigating the role of non-clinical factors to LOS of patients

with traumatic injuries demonstrated that insurance status and discharge location were strongly associated with LOS [74]. In more detail, patients with Medicaid had significantly longer LOS in comparison to patients with commercial insurance. Moreover, patients that were discharged to a nursing home or a rehabilitation facility had longer LOS in comparison to patients that were discharged to other location. These results were also confirmed by other smaller studies [86-88].

Many other hospital factors have been proposed as possible predictors of prolonged LOS including infections acquired at the health care facility, unsuitable clinical facilities, inappropriate staff training and absence of health care centers [14]. However, in our research we did not find any studies that investigated the aforementioned factors for SCI

patients. More studies should be oriented towards this direction in the future.

In conclusion, our review showed that patients' determinants such as severity and etiology of the injury, as well as secondary medical complications can lead to prolonged hospitalization of SCI patients. Additionally, hospital determinants can also affect LOS and result to extended stay in the health facility. Therefore, all these factors should be taken seriously into account by all health professionals to reduce LOS and consequently provide a better functional outcome after rehabilitation. At the same time, the reduction of LOS, apart from achieving improved rehabilitation outcomes, may also assist to the significant reduction of private and health-care system expenses. 

REFERENCES

1. Lamontagne, M.-E., et al., *Effect of rehabilitation length of stay on outcomes in individuals with traumatic brain injury or spinal cord injury: a systematic review protocol*. Systematic reviews, 2013. **2**(1): p. 1-4. <https://systematicreviewsjournal.biomedcentral.com/articles/10.1186/2046-4053-2-59>
2. Myers, J., M. Lee, and J. Kiratli, *Cardiovascular disease in spinal cord injury: an overview of prevalence, risk, evaluation, and management*. American journal of physical medicine & rehabilitation, 2007. **86**(2): p. 142-152. <http://cardiology.org/recentpapers/PDF307/SCI%20CV%20Health%20Review.pdf>
3. O'Connor, R. and P. Murray, *Review of spinal cord injuries in Ireland*. Spinal cord, 2006. **44**(7): p. 445-448. <https://www.nature.com/articles/3101856>
4. Noonan, V.K., et al., *Incidence and prevalence of spinal cord injury in Canada: a national perspective*. Neuroepidemiology, 2012. **38**(4): p. 219-226. <https://www.karger.com/Article/PDF/336014>
5. Löfvenmark, I., et al., *Traumatic spinal cord injury in Botswana: characteristics, aetiology and mortality*. Spinal cord, 2015. **53**(2): p. 150-154. <https://www.nature.com/articles/sc2014203>
6. Sabre, L., et al., *Impact of fatal cases on the epidemiology of traumatic spinal cord injury in Estonia*. European Journal of Neurology, 2015. **22**(5): p. 768-772.
7. Divanoglou, A. and R. Levi, *Incidence of traumatic spinal cord injury in Thessaloniki, Greece and Stockholm, Sweden: a prospective population-based study*. Spinal cord, 2009. **47**(11): p. 796-801. <https://www.nature.com/articles/sc200928/>
8. Tator, C.H., *Update on the pathophysiology and pathology of acute spinal cord injury*. Brain pathology, 1995. **5**(4): p. 407-413.
9. Norton, L., *Spinal Cord Injury, Australia, 2007-08*. 2010: Australian Institute of Health and Welfare Canberra. https://www.researchgate.net/profile/Lynda_Norton/publication/228715043_Spinal_Cord_Injury_Australia_2007-08/links/546001640cf295b56161cbe0/Spinal-Cord-Injury-Australia-2007-08.pdf
10. Jang, H.J., J. Park, and H.-I. Shin, *Length of hospital stay in patients with spinal cord injury*. Annals of Rehabilitation Medicine, 2011. **35**(6): p. 798. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3309389/>
11. Ronen, J., et al., *Length of stay in hospital following spinal cord lesions in Israel*. Spinal Cord, 2004. **42**(6): p. 353-358. <https://www.nature.com/articles/3101590>
12. Middleton, J., et al., *Patterns of morbidity and rehospitalisation following spinal cord injury*. Spinal cord, 2004. **42**(6): p. 359-367. <https://www.nature.com/articles/3101601>
13. Jiménez-Ávila, J.M., A. Calderón-Granados, and W.E. Bitar-Alatorre, *Direct cost of spinal cord injuries*. Cirugía y Cirujanos, 2012. **80**(5): p. 435-441.
14. Mawajdeh, S., Y. Hayajneh, and R. Al-Qutob, *The effect of type of hospital and health insurance on hospital length of stay in Irbid, North Jordan*. Health policy and planning, 1997. **12**(2):

- p. 166-172.
15. Eastwood, E.A., et al., *Medical rehabilitation length of stay and outcomes for persons with traumatic spinal cord injury – 1990–1997*. Archives of physical medicine and rehabilitation, 1999. **80**(11): p. 1457-1463. [https://www.archives-pmr.org/article/S0003-9993\(99\)90258-7/pdf](https://www.archives-pmr.org/article/S0003-9993(99)90258-7/pdf)
 16. Herm, F.B., J. Spackman, and A.M. Anderson, *Experiences with family supported rehabilitation of people with spinal cord injury*. Asia Pac Disabil Rehab J, 2000. **11**: p. 31-34. <https://www.dinf.ne.jp/doc/english/asia/resource/apdrj/z13jo0500/z13jo0510.html>
 17. Simpson, S., et al., *Predicting the impact of new health technologies on average length of stay: development of a prediction framework*. International journal of technology assessment in health care, 2005. **21**(4): p. 487. https://www.researchgate.net/profile/Sue_Simpson/publication/7504153_Predicting_the_impact_of_new_health_technologies_on_average_length_of_stay_Development_of_a_prediction_framework/links/549154c30cf214269f27ffe1.pdf
 18. Chappell, P. and S. Wirz, *Quality of life following spinal cord injury for 20-40 year old males living in Sri Lanka*. Asia Pac Disabil Rehabil J, 2003. **14**(14): p. 162-178.
 19. Lim, P.A. and A.M. Tow, *Recovery and regeneration after spinal cord injury: a review and summary of recent literature*. Annals-Academy of Medicine Singapore, 2007. **36**(1): p. 49. <http://www.annals.edu.sg/pdf/36volno1jan2007/v36n1p49.pdf>
 20. Post, M.W., et al., *Duration and functional outcome of spinal cord injury rehabilitation in the Netherlands*. Journal of rehabilitation research and development, 2005. **42**(3): p. 75. https://www.researchgate.net/profile/Lucas_Woude/publication/7569065_Duration_and_functional_outcome_of_spinal_cord_injury_rehabilitation_in_the_Netherlands/links/0912f50ec3f09bc569000000.pdf
 21. Scivoletto, G., et al., *Effects on age on spinal cord lesion patients' rehabilitation*. Spinal Cord, 2003. **41**(8): p. 457-464. <https://www.nature.com/articles/3101489>
 22. Roth, E., et al., *The older adult with a spinal cord injury*. Spinal Cord, 1992. **30**(7): p. 520-526. <https://www.nature.com/articles/sc1992109.pdf?origin=ppub>
 23. Milicevic, S., et al., *Predictors of Length of Stay in Patients with Spinal Cord Injury*. Physikalische Medizin, Rehabilitationsmedizin, Kurortmedizin, 2015. **25**(03): p. 136-140.
 24. Pagliacci, M.C., et al., *An Italian survey of traumatic spinal cord injury. The Gruppo Italiano studio epidemiologico Mielolesioni study*. Archives of physical medicine and rehabilitation, 2003. **84**(9): p. 1266-1275. [https://www.archives-pmr.org/article/S0003-9993\(03\)00234-X/fulltext](https://www.archives-pmr.org/article/S0003-9993(03)00234-X/fulltext)
 25. Cifu, D.X., et al., *Age, outcome, and rehabilitation costs after paraplegia caused by traumatic injury of the thoracic spinal cord, conus medullaris, and cauda equina*. Journal of neurotrauma, 1999. **16**(9): p. 805-815.
 26. DeVivo, M.J., et al., *The influence of age at time of spinal cord injury on rehabilitation outcome*. Archives of neurology, 1990. **47**(6): p. 687-691. https://www.researchgate.net/profile/Michael_DeVivo2/publication/20810485_The_Influence_of_Age_at_Time_of_Spinal_Cord_Injury_on_Rehabilitation_Outcome/links/550507410cf231de07758ecb/The-Influence-of-Age-at-Time-of-Spinal-Cord-Injury-on-Rehabilitation-Outcome.pdf
 27. Furlan, J., D. Kattail, and M. Fehlings, 171. *Age and Co-morbidity Indices as Potential Predictors of In-hospital Mortality and Length of Hospitalization in Patients with Acute Spine Trauma: A Retrospective Cohort Study of 261 Patients*. The Spine Journal, 2008. **8**(5): p. 875.
 28. Al-Jadid, M.S. and A.A. Robert, *An analysis of the length of stay in traumatic and non-traumatic spinal cord injured patients*. Saudi Med J, 2010. **31**(5): p. 555-9.
 29. Tuğcu, İ., et al., *Epidemiologic data of the patients with spinal cord injury: Seven years' experience of a single center*. Turkish Journal of Trauma and Emergency Surgery, 2011. **17**(6): p. 533-538. <http://www.tjtes.org/eng/jvi.aspx?pidir=travma&plng=eng&un=UTD-95676>
 30. Tator, C., et al., *Complications and costs of management of acute spinal cord injury*. Spinal Cord, 1993. **31**(11): p. 700-714. <https://www.nature.com/articles/sc1993112.pdf?origin=ppub>
 31. Cifu, D.X., et al., *A multicenter investigation of age-related differences in lengths of stay, hospitalization charges, and outcomes for a matched tetraplegia sample*. Archives of physical medicine and rehabilitation, 1999. **80**(7): p. 733-740. [https://www.archives-pmr.org/article/S0003-9993\(99\)90219-8/pdf](https://www.archives-pmr.org/article/S0003-9993(99)90219-8/pdf)
 32. Greenwald, B.D., et al., *Gender-related differences in acute rehabilitation lengths of stay, charges, and functional outcomes for a matched sample with spinal cord injury: a multicenter investigation*. Archives of physical medicine and rehabilitation, 2001. **82**(9): p. 1181-1187. <https://www.archives-pmr.org/>

- article/S0003-9993(01)15539-5/fulltext
33. Go, B.K., *The epidemiology of spinal cord injury*. Spinal cord injury: clinical outcomes from the model systems, 1995.
 34. Charlifue, S.W., D.A. Weitzenkamp, and G.G. Whiteneck, *Longitudinal outcomes in spinal cord injury: aging, secondary conditions, and well-being*. Archives of physical medicine and rehabilitation, 1999. **80**(11): p. 1429-1434. [https://www.archives-pmr.org/article/S0003-9993\(99\)90254-X/pdf](https://www.archives-pmr.org/article/S0003-9993(99)90254-X/pdf)
 35. Pompei, P., et al., *Relating patient characteristics at the time of admission to outcomes of hospitalization*. Journal of clinical epidemiology, 1991. **44**(10): p. 1063-1069.
 36. Burr, R., L. Clift-Peace, and I. Nuseibeh, *Haemoglobin and albumin as predictors of length of stay of spinal injured patients in a rehabilitation centre*. Spinal Cord, 1993. **31**(7): p. 473-478. <https://www.nature.com/articles/sc199376.pdf?origin=ppub>
 37. Rhie, K.S., et al., *The Discharge Destination of Rehabilitation Inpatients in a Tertiary Hospital*. Journal of the Korean Academy of Rehabilitation Medicine, 2005. **29**(1): p. 135-140. <https://www.e-arm.org/upload/pdf/Jkarm029-01-22.pdf>
 38. Tooth, L., K. McKenna, and T. Geraghty, *Rehabilitation outcomes in traumatic spinal cord injury in Australia: functional status, length of stay and discharge setting*. Spinal cord, 2003. **41**(4): p. 220-230. <https://www.nature.com/articles/3101433>
 39. Celani, M.G., et al., *Spinal cord injury in Italy: a multicenter retrospective study*. Archives of physical medicine and rehabilitation, 2001. **82**(5): p. 589-596. <https://www.archives-pmr.org/article/S0003-9993%2801%2991851-9/fulltext>
 40. New, P.W., H.B. Rawicki, and M.J. Bailey, *Nontraumatic spinal cord injury: demographic characteristics and complications*. Archives of physical medicine and rehabilitation, 2002. **83**(7): p. 996-1001. [https://www.archives-pmr.org/article/S0003-9993\(02\)00017-5/fulltext](https://www.archives-pmr.org/article/S0003-9993(02)00017-5/fulltext)
 41. Burnett, D.M., et al., *Spinal cord injury "outliers": An analysis of etiology, outcomes, and length of stay*. Journal of neurotrauma, 2000. **17**(9): p. 765-772.
 42. McKinley, W.O., et al., *Nontraumatic vs. traumatic spinal cord injury: a rehabilitation outcome comparison*. American journal of physical medicine & rehabilitation, 2001. **80**(9): p. 693-699.
 43. Gupta, A., et al., *Traumatic vs non-traumatic spinal cord lesions: comparison of neurological and functional outcome after in-patient rehabilitation*. Spinal Cord, 2008. **46**(7): p. 482-487. <https://www.nature.com/articles/3102168/>
 44. Chen, D., et al., *Medical complications during acute rehabilitation following spinal cord injury – current experience of the Model Systems*. Archives of physical medicine and rehabilitation, 1999. **80**(11): p. 1397-1401. [https://www.archives-pmr.org/article/S0003-9993\(99\)90250-2/pdf](https://www.archives-pmr.org/article/S0003-9993(99)90250-2/pdf)
 45. Haisma, J.A., et al., *Complications following spinal cord injury: occurrence and risk factors in a longitudinal study during and after inpatient rehabilitation*. Journal of rehabilitation medicine, 2007. **39**(5): p. 393-398. <https://www.ingentaconnect.com/contentone/mjl/sreh/2007/00000039/00000005/art00009?crawler=true&mimetype=application/pdf>
 46. Joseph, C. and L.N. Wikmar, *Prevalence of secondary medical complications and risk factors for pressure ulcers after traumatic spinal cord injury during acute care in South Africa*. Spinal Cord, 2016. **54**(7): p. 535-539. <https://www.nature.com/articles/sc2015189>
 47. Guihan, M., et al., *Predictors of pressure ulcer recurrence in veterans with spinal cord injury*. The journal of spinal cord medicine, 2008. **31**(5): p. 551-559. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2607128/>
 48. Niazi, Z.B., et al., *Recurrence of initial pressure ulcer in persons with spinal cord injuries*. Advances in Skin & Wound Care, 1997. **10**(3): p. 38-42.
 49. Chu, D., et al., *Prevalence of associated injuries of spinal trauma and their effect on medical utilization among hospitalized adult subjects—a nationwide data-based study*. BMC health services research, 2009. **9**(1): p. 1-8. <https://bmchealthservres.biomedcentral.com/articles/10.1186/1472-6963-9-137>
 50. Wu, Q., et al., *Factors affecting the length of stay of patients with traumatic spinal cord injury in Tianjin, China*. The journal of spinal cord medicine, 2013. **36**(3): p. 237-242. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3654451/>
 51. Ash, D., *An exploration of the occurrence of pressure ulcers in a British spinal injuries unit*. Journal of Clinical Nursing, 2002. **11**(4): p. 470-478.
 52. New, P.W., H.B. Rawicki, and M.J. Bailey, *Nontraumatic spinal cord injury rehabilitation: pressure ulcer patterns, prediction, and impact*. Archives of physical medicine and rehabilitation, 2004. **85**(1): p. 87-93. [https://www.archives-pmr.org/article/S0003-9993\(03\)00378-2/fulltext](https://www.archives-pmr.org/article/S0003-9993(03)00378-2/fulltext)
 53. Young, J. and P. Burns, *Pressure sores and the spinal cord in-*

- jured. *Sci Digest*, 1981. **3**(3): p. 9-17.
54. Vaidyanathan, S., et al., *Protocol of a prospective cohort study of the effect of different methods of drainage of neuropathic bladder on occurrence of symptomatic urinary infection, and adverse events related to the urinary drainage system in spinal cord injury patients*. *BMC urology*, 2001. **1**(1): p. 2. <https://link.springer.com/article/10.1186/1471-2490-1-2>
 55. Van Kerrebroeck, P., et al., *The morbidity due to lower urinary tract function in spinal cord injury patients*. *Spinal Cord*, 1993. **31**(5): p. 320-329. <https://www.nature.com/articles/sc199356.pdf?origin=ppub>
 56. DE RUZ, A.E., E.G. LEONI, and R.H. CABRERA, *Epidemiology and risk factors for urinary tract infection in patients with spinal cord injury*. *The Journal of urology*, 2000. **164**(4): p. 1285-1289.
 57. Perrouin-Verbe, B., et al., *Clean intermittent catheterisation from the acute period in spinal cord injury patients. Long term evaluation of urethral and genital tolerance*. *Spinal Cord*, 1995. **33**(11): p. 619-624. <https://www.nature.com/articles/sc1995131.pdf?origin=ppub>
 58. Montgomerie, J.Z., *Infections in patients with spinal cord injuries*. *Clinical infectious diseases*, 1997. **25**(6): p. 1285-1290.
 59. Berly, M. and K. Shem, *Respiratory management during the first five days after spinal cord injury*. 2007, Taylor & Francis.
 60. Werhagen, L., *Analysis of neuropathic pain after spinal cord injury*. 2008: Institutionen för kliniska vetenskaper, Danderyds sjukhus/Department of Clinical Sciences, Danderyd Hospital.
 61. Smith, B.M., et al., *Acute respiratory tract infection visits of veterans with spinal cord injuries and disorders: rates, trends, and risk factors*. *The journal of spinal cord medicine*, 2007. **30**(4): p. 355-361. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2031934/>
 62. Lemons, V.R. and F.C. Wagner Jr, *Respiratory Complications After Cervical Spinal Cord Injury*. *Spine*, 1994. **19**(20): p. 2315-2320.
 63. Fishburn, M., R. Marino, and J. Ditunno Jr, *Atelectasis and pneumonia in acute spinal cord injury*. *Archives of physical medicine and rehabilitation*, 1990. **71**(3): p. 197.
 64. Jackson, A.B. and T.E. Groomes, *Incidence of respiratory complications following spinal cord injury*. *Archives of physical medicine and rehabilitation*, 1994. **75**(3): p. 270-275. [https://www.archives-pmr.org/article/0003-9993\(94\)90027-2/pdf](https://www.archives-pmr.org/article/0003-9993(94)90027-2/pdf)
 65. Davies, D.S. and M.A. McColl, *Lifestyle risks for three disease outcomes in spinal cord injury*. *Clinical Rehabilitation*, 2002. **16**(1): p. 96-108.
 66. Winslow, C., et al., *Impact of respiratory complications on length of stay and hospital costs in acute cervical spine injury*. *Chest*, 2002. **121**(5): p. 1548-1554. <https://pdfs.semanticscholar.org/c73d/1ebd7d8f8ff7a5f95a66e21519993f2563f9.pdf>
 67. Lagoe, R.J., *Hospital stays by diagnosis related group for neurologic patients treated medically*. *Neurology*, 1987. **37**(1): p. 139-139.
 68. Wolinsky, F., R. Coe, and R. Mosely, *The process and outcome of hospital care for Medicaide versus privately insured hospital patient*. 1987.
 69. Burns, A.S., et al., *Understanding length of stay after spinal cord injury: insights and limitations from the access to care and timing project*. *Journal of Neurotrauma*, 2017. **34**(20): p. 2910-2916. <https://www.liebertpub.com/doi/pdf-plus/10.1089/neu.2016.4935>
 70. Burns, L.R. and D.R. Wholey, *The effects of patient, hospital, and physician characteristics on length of stay and mortality*. *Medical care*, 1991: p. 251-271.
 71. Pandey, V., et al., *Care of post-traumatic spinal cord injury patients in India: an analysis*. *Indian journal of orthopaedics*, 2007. **41**(4): p. 295. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2989513/>
 72. Ginis, K.A.M., et al., *Leisure time physical activity in a population-based sample of people with spinal cord injury part I: demographic and injury-related correlates*. *Archives of physical medicine and rehabilitation*, 2010. **91**(5): p. 722-728. <https://www.archives-pmr.org/article/S0003-9993%2810%2900086-9/fulltext>
 73. Epstein, A.M., R.S. Stern, and J.S. Weissman, *Do the poor cost more? A multihospital study of patients' socioeconomic status and use of hospital resources*. *New England Journal of Medicine*, 1990. **322**(16): p. 1122-1128. <https://www.nejm.org/doi/full/10.1056/NEJM199004193221606>
 74. Brasel, K.J., et al., *Length of stay: an appropriate quality measure?* *Archives of Surgery*, 2007. **142**(5): p. 461-466. <https://jamanetwork.com/journals/jamasurgery/fullarticle/400154>
 75. McAleese, P. and W. Odling-Smee, *The effect of complications on length of stay*. *Annals of surgery*, 1994. **220**(6): p. 740. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1234475/pdf/annsurg00058-0046.pdf>

76. Zakrasek, E., G. Creasey, and J. Crew, *Pressure ulcers in people with spinal cord injury in developing nations*. Spinal Cord, 2015. **53**(1): p. 7-13. <https://www.nature.com/articles/sc2014179>
77. Regan, M., et al., *Pressure ulcers following spinal cord injury*. Spinal cord injury rehabilitation evidence. Version, 2010. 3. <https://gneaupp.info/wp-content/uploads/2014/12/pressureulcersfollowingsspinalcordinjury.pdf>
78. Cardozo, C.P., *Respiratory complications of spinal cord injury*. The journal of spinal cord medicine, 2007. **30**(4): p. 307. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2031931/>
79. Karlet, M.C., *Acute management of the patient with spinal cord injury*. International Journal of Trauma Nursing, 2001. **7**(2): p. 43-48.
80. March, A., *A review of respiratory management in spinal cord injury*. Journal of orthopaedic nursing, 2005. **9**(1): p. 19-26.
81. Salomon, J.m., et al., *Prevention of urinary tract infection in spinal cord-injured patients: safety and efficacy of a weekly oral cyclic antibiotic (WOCA) programme with a 2 year follow-up – an observational prospective study*. Journal of Antimicrobial Chemotherapy, 2006. **57**(4): p. 784-788. <https://academic.oup.com/jac/article/57/4/784/669374>
82. O'Keefe, G.E., G.J. Jurkovich, and R.V. Maier, *Defining excess resource utilization and identifying associated factors for trauma victims*. Journal of Trauma and Acute Care Surgery, 1999. **46**(3): p. 473-478.
83. Celik, Y., et al., *Inappropriate use of hospital beds: a case study of university hospitals in Turkey*. World hospitals and health services: the official journal of the International Hospital Federation, 2001. **37**(1): p. 6-13, 33-4.
84. Panis, L.J., F.W. Verheggen, and P. Pop, *To stay or not to stay. The assessment of appropriate hospital stay, a Dutch report*. International Journal for Quality in Health Care, 2002. **14**(1): p. 55-67. <https://academic.oup.com/intqhc/article/14/1/55/2743494>
85. Anzai, K., et al., *Factors influencing discharge location following high lesion spinal cord injury rehabilitation in British Columbia, Canada*. Spinal Cord, 2006. **44**(1): p. 11-18. <https://www.nature.com/articles/3101778>
86. Brasel, K.J., et al., *Reasons for delayed discharge of trauma patients*. Journal of Surgical Research, 2002. **107**(2): p. 223-226.
87. Chan, L., et al., *Discharge disposition from acute care after traumatic brain injury: the effect of insurance type*. Archives of physical medicine and rehabilitation, 2001. **82**(9): p. 1151-1154. [https://www.archives-pmr.org/article/S0003-9993\(01\)95140-8/fulltext](https://www.archives-pmr.org/article/S0003-9993(01)95140-8/fulltext)
88. Thomas, S.N., G. McGwin Jr, and L.W. Rue III, *The financial impact of delayed discharge at a level I trauma center*. Journal of Trauma and Acute Care Surgery, 2005. **58**(1): p. 121-125.

READY - MADE
CITATION

Fotopoulou S, Benetos IS, Pneumaticos S, Vlamis J. Factors that prolong hospitalization of patients with spinal cord injury. *Acta Orthop Trauma Hell* 2021; **72**(2): 185-195.