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# OCCUPATIONAL SPINAL CORD INJURY – EPIDEMIOLOGY AND COSTS

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## ABSTRACT

Spinal cord injury (SCI) is one of the most severe injuries that can happen in the workplace. There is no cure for SCI, and a majority of cases does not improve functionally even after rehabilitation. Primary prevention has to be the key target in order to get better rehabilitation outcomes and on the other hand, reduce the whole rehabilitation costs.
There are very few published reviewed epidemiological works addressing SCIs that occur in the workplace and even fewer, that estimate the post-injury economics. There are not any of the second in the European region. The annual incidence of traumatic spinal cord injury (SCI) in the United States (US) is approximately four per 100 000 population. In the workplace, spinal cord injuries represent less than one out of every 10 000 injuries, but the costs for these injuries are among the highest in the workers' compensation system. In Australian community, only 64% of cases of SCI receive compensation for their injury.
The majority of work-related injuries appear as a result of falls and vehicular accidents, with a higher proportion of lumbar and fewer cervical injuries. In Australia the labour force based rate of SCI was highest for farmers (17 cases per million) mostly as a result of a fall from a horse. Also car crashes were a common cause of work related SCI, resulting from the vehicle rollover and mostly referred to 4-wheel drive vehicles, and other vehicles with a high centre of gravity, easy to roll.
The majority of the SCI population in USA are male and almost 25% work in the construction industry. The cost of SCI suggests that those with work-related tetraplegia receive a higher level of reimbursement for postacute services than those with other insurance coverage. The first year post-injury medical costs for SCI are the highest comparably with each of the following years. There is district difference between those with high-level versus low-level tetraplegia and the estimations point that ASIA D injuries cost significantly less than injuries of ASIA types A–C and in this case, Walsh and DeRavin presented the cost of the long term care of each new case of SCI in Australia ranged from approximately $602 000 for a paraplegic, $1 175 000 for a tetraplegic, and $4 000 000 for a ventilator dependent tetraplegic. On the other hand, the estimations by the National Spinal Cord Injury Statistical Center in USA, refer to a lifetime healthcare and living costs for a person sustaining a tetraplegic injury at age 25, to range from approximately $1.2 million for low-tetraplegia cases (C5–8 ASIA A–C) to $2.2 million for high-tetraplegia cases (C1–4 ASIA A–C). The way countries and their relevant organizations act on these cases of work related SCIs appears different. In the case of the European Union policy which addresses with multiple cultural and political member remarks, there's a need to design a baseline approach for the prevention – hospitalization – post injury cost coverage – pension and reaccession to the community .

Key words: Spinal cord injury, economics, cost effectiveness, epidemiological characteristics

## 1. INTRODUCTION

Little has been published before on the epidemiology and costs of work related spinal cord injury (SCI). Spinal cord injury (SCI) is one of the most severe and debilitating injuries that can be suffered in the workplace. As there is no cure for SCI, and the level of impairment does not improve substantially for the vast majority of cases even after rehabilitation, it is arguable that primary prevention should receive substantially greater emphasis. Even work-related SCI represents less than one out of every 10 000 injuries in the US, the costs for these injuries are among the highest in the workers' compensation system. It requires significant and expensive medical intervention, including prolonged hospitalization and intense in-patient treatment and rehabilitation. Patients at high risk for extended lengths of stay must be identified early and this will help the clinicians to apply more aggressive treatment and family and sponsors to estimate the cost of long-term care (Burnett 2003). Although SCIs refer to all levels of vertebral column accidents including paraplegia (low level thoraco-lumbar accidents), tetraplegia caused from cervical injuries is the most hospitalization and cost demanding case. There is district difference between those with high-level versus low-level tetraplegia and the estimations point that ASIA D injuries cost significantly less than injuries of ASIA types A–C. In this case, Walsh and DeRavin presented in a study, the cost of the long term care of each new case of SCI in Australia ranged from approximately $602 000 for a paraplegic, $1 175 000 for a tetraplegic, and $4 000 000 for a ventilator dependent tetraplegic.

Tetraplegia cases represent over 50% of SCIs, and are the most costly in the USA (Webster 2004). The lifetime healthcare and living costs for a person sustaining a tetraplegic injury at age 25 have been estimated by the National Spinal Cord Injury Statistical Center to range from approximately $1.2 million for low-tetraplegia cases (C5–8 ASIA A–C) to $2.2 million for high-tetraplegia cases (C1–4 ASIA A–C) (NSCISC 2001), (see **Table 1**, ASIA scale definition).

For these cases, there are two main databases for use to estimate the medical costs of the SCI incidences during and after hospitalization. One is the US Worker's Compensatioin database (WC) and the other, the National Spinal Cord Injury Database (NSCID) established back to 1973. The NSCI database contains information on all patients receiving care from the Model SCI Care System Centers and captures approximately 13% of all new cases of SCI in the US (DeVivo 1995). When WC insurance is the first payor for a work-related SCI, all medical and rehabilitation charges are forwarded to the WC insurer. This continues even if a person with work-related SCI qualifies for Social Security and Medicare insurance. The WC databases are able to capture complete documentation of injury-related medical expenditures. The payment begins on the date of injury and is comprehensive for acute and rehabilitation hospitalizations and readmissions, physician and therapy services, medications and supplies, durable equipment, transportation, environmental modifications, attendant care, and vocational rehabilitation, among other injury-related expenses (Webster 2004). In the early days of the NSCID, detailed service records were kept until 1983. Since then, the only information captured by the NSCID relevant to services provided following SCI is: acute hospital care and rehabilitation length of stay and associated charges while in the Model SCI care system, length of readmission, time spent in nursing homes, and sponsors of care (Young 2004). Thus, the WC seems to be more accurate to provide the majority of cost expenses data about SCI admissions.

**Table 1: ASIA impairment scale**

| Grade | Description |
|---|---|
| A | Complete; no sensory or motor function preserved in the sacral segments S4–S5 |
| B | Incomplete; sensory but not motor function preserved below the numerological level and extending through the<br>sacral segment S4–S5 |
| C | C Incomplete; motor function preserved below the neurological level; most (more than half) key muscles have a<br>grade <3. Sensory function is present below the neurological level and includes sacral segments S4–S5 |
| D | D Incomplete; motor function preserved below the neurological level; most (at least half) key muscles have a grade<br>3 or more. Sensory function is present below the neurological level and includes sacral segments S4–S5 |
| E | Normal motor and sensory function |

**SOURCE**: (McDonald JW & Sadowsky C., 2002)

## 2. MAIN TOPICS INFLUENCE THE COST AND COST EFFECTIVENESS

- Injury epidemiological characteristics
- Hospitalization & Services
- Re-Hospitalization
- Outliers
- Cost effectiveness

### 2.1 Injury epidemiological characteristics

In 2004, nearly 5 percent of all hospital stays—about 1.9 million hospitalizations—were for treatment of an injury (HCUP 2004). These stays totaled $19.5 billion dollars in hospital costs, accounting for 6.6 percent of the total cost of hospital care in the United States. Certain injuries like intracranial injuries, spinal cord injuries, burns, internal injuries, and hip fracture were more expensive and required longer lengths of stay than all other injuries. It is interesting that even Spinal cord injury appears last in the ranking of injuries frequency, with only 0.8% percentage of stays, was the most expensive injury ($36,900) and required the longest hospital stay (13.5 days), (HCUP 2004), (**Table 2**).

The majority of work-related Spinal Cord Injuries appear as a result of falls and vehicular accidents, with a higher proportion of lumbar and fewer cervical injuries (**table 3**) (O'Connor 2001, Bagnall 2003, Webster 2004, Young 2004). In Australia the labour force based rate of SCI was highest for farmers (17 cases per million) mostly as a result of a fall from a horse. Also car crashes were a common cause of work related SCI, resulting from the vehicle rollover and mostly referred to 4-wheel drive vehicles, and other vehicles with a high centre of gravity, easy to roll (O'Connor, 2001). Heavy industry and constructions have the major proportion of the work related SCIs, (**figure 1**) (Bagnall 2003, Webster 2004).

**Table 2: Common injuries resulting in hospitalization, 2004**

| | **Principal diagnosis** | **Total number of stays** | **Percentage of injury stays** | **Mean hospital cost** | **Mean length of stay(days)** | **In-hospital death rate** |
|---|---|---|---|---|---|---|
| 1 | Hip fracture | 304,300 | 16.0% | $12,000 | 6.3 | 2.9% |
| 2 | Leg fracture | 284,900 | 15.0% | $10,700 | 4.7 | 0.6% |
| 3 | Spine, rib and pelvis fractures | 187,500 | 9.9% | $10,200 | 5.5 | 1.4% |
| 4 | Intracranial (brain) injury | 186,100 | 9.8% | $16,300 | 6.8 | 10.2% |
| 5 | Arm fracture | 162,300 | 8.6% | $7,700 | 3.3 | 0.4% |
| 6 | Poisoning by medications other than psychiatric medications | 148,000 | 7.8% | $5,000 | 2.8 | 1.3% |
| 7 | Crushing injury or internal injury | 119,000 | 6.3% | $16,200 | 6.9 | 4.0% |
| 8 | Poisoning by psychiatric drugs | 78,600 | 4.2% | $4,500 | 2.4 | 0.7% |
| 9 | Other injuries | 69,100 | 3.6% | $6,600 | 3.5 | 2.7% |
| 10 | Superficial injury, bruise | 58,100 | 3.1% | $4,300 | 3.0 | 0.5% |
| 11 | Open wounds of arms and legs | 57,500 | 3.0% | $7,100 | 3.6 | 0.2% |
| 12 | Skull and face fractures | 54,900 | 2.9% | $9,700 | 3.6 | 0.6% |
| 13 | Sprains and strains | 53,200 | 2.8% | $4,600 | 2.3 | * |
| 14 | Open wounds of head, neck, and trunk | 43,000 | 2.3% | $6,300 | 2.7 | 0.7% |
| 15 | Burns | 32,500 | 1.7% | $17,600 | 8.9 | 4.1% |
| 16 | Poisoning by substances other than medicine | 24,900 | 1.3% | $5,700 | 2.8 | 1.2% |
| 17 | Joint disorders and dislocations due to trauma | 17,200 | 0.9% | $8,200 | 3.5 | 0.8% |
| 18 | Spinal cord injury | 15,600 | 0.8% | $36,900 | 13.5 | 5.7% |
| | **All injuries** | **1,896,587** | **100.0%** | **$10,300** | **4.8** | **2.4%** |

*Based on principal diagnosis.

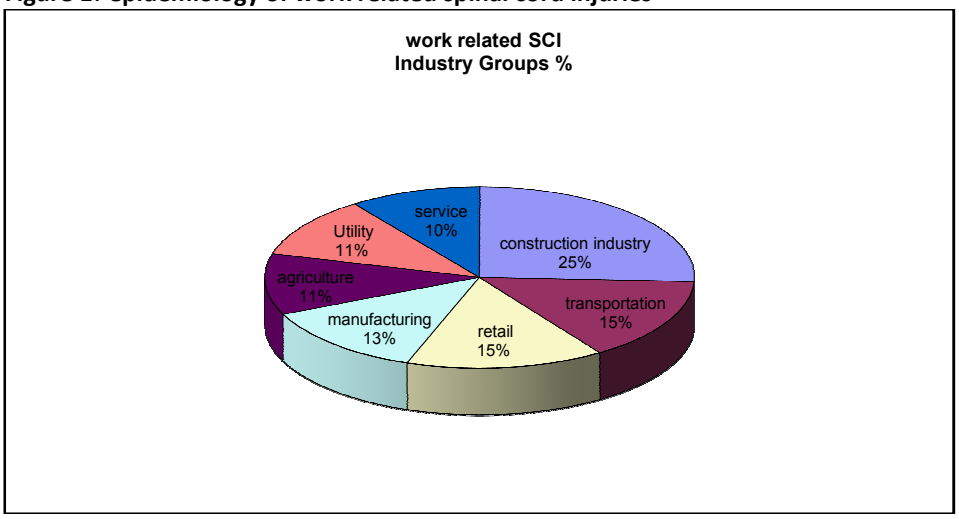
**SOURCE**: (HCUP - AHRQ, Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project, Nationwide Inpatient Sample, 2004)

**Table .3 Cause of Injury**

| Cause of Injury |
|---|
| Fall 35.5% |
| Vehicular accident 33.9% |
| Struck by/against 21.0% |
| Violence 3.2% |
| Sports 3.2% |
| Other 3.2% |

**SOURCE:** (O'Connor 2001, Bagnall 2003, Webster 2004, Young 2004)

**Figure 1: epidemiology of work related spinal cord injuries**

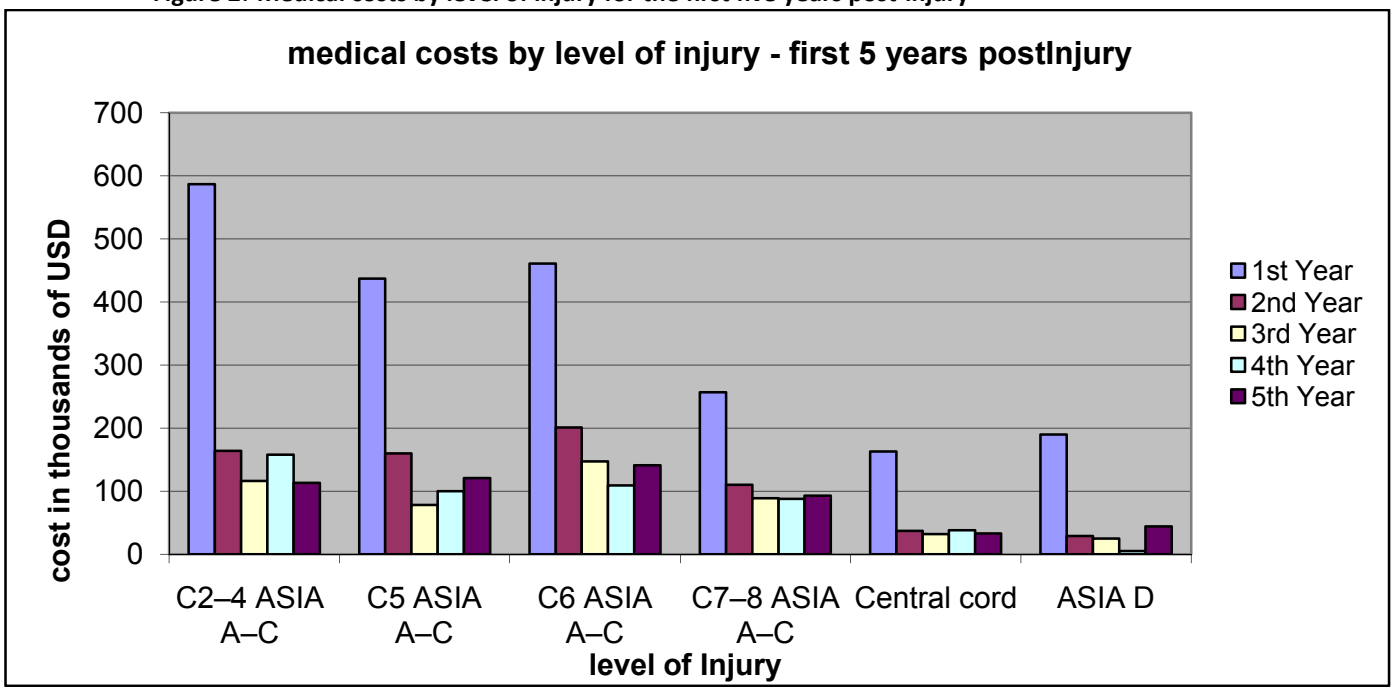



**SOURCE:** (Bagnall 2003, Webster 2004)

### 2.2.1 Hospitalization

The medical costs, are significantly higher in Year 1 than in the following years for all injury categories (Webster 2004) (**Figure 2**). The average acute hospitalization length of stay is approximately 22.63 days with an analogue decrease following the severity of injury. The length of acute hospitalization is significantly shorter for those patients with an ASIA D impairment in comparison with High Tetraplegia. The mean length of stay for acute rehabilitation, is longest for those with low tetraplegia and the shortest for ASIA D cases (**Figure 3**) (Young 2004).

**Figure 2: Medical costs by level of injury for the first five years post-injury**




**SOURCE:** (Webster 2004)

## 2.2.2 Services

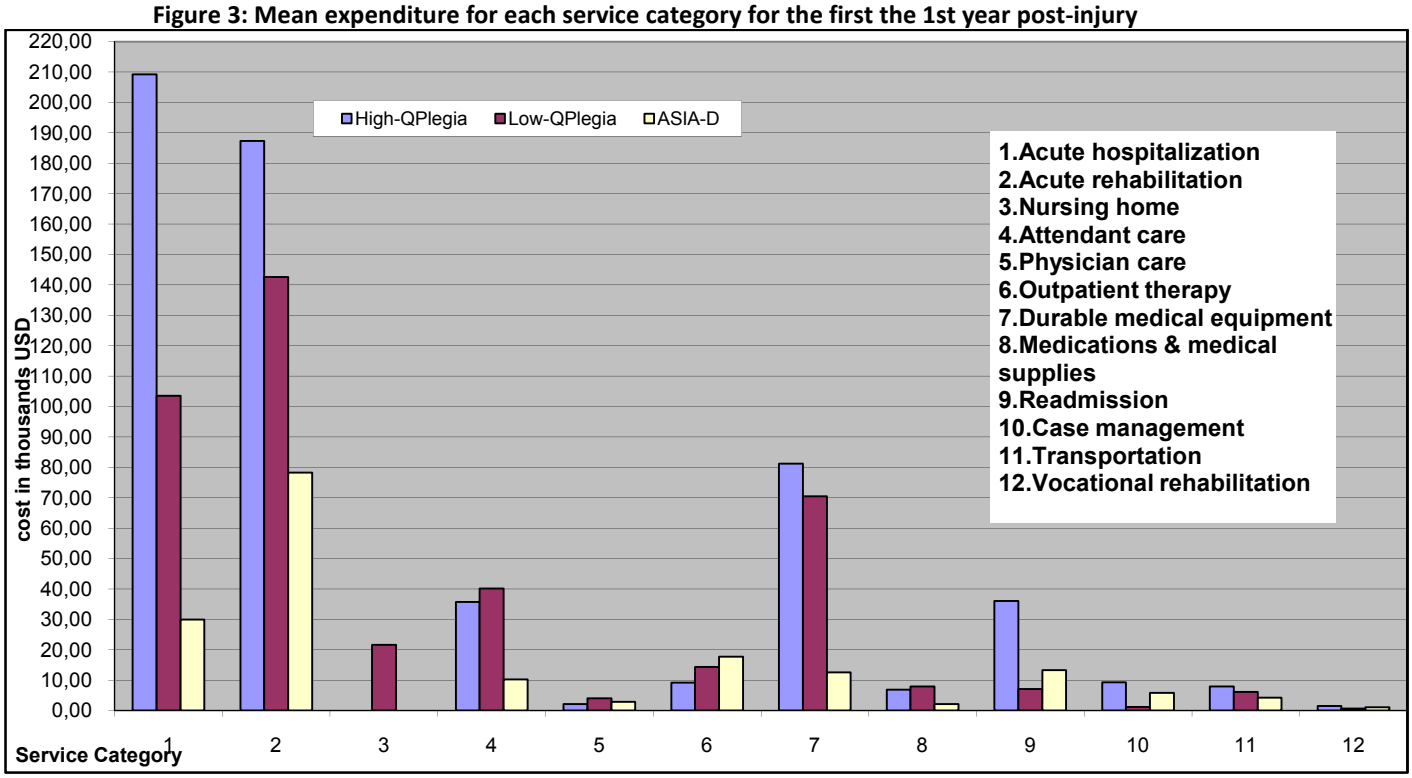
The main services providing following SCIs include: Acute hospitalization – Acute Rehabilitation – Nursing at Home – Attend Care – Physician Care – Outpatient Therapy – Durable Medical Equipment (DME)– Medication and Medical Supplies – Readmissions – Case Management – Transportation and Vocational Rehabilitation. The mean expenditure for each service category during the 1st Year and the following 4 years, are presented in **Figures 3 & 4** respectively (Webster 2004, Young 2004, Young 2006). After acute hospitalization and acute rehabilitation, the service categories that cost more are DME and attendant care.

**Table .2 Services provided after acute Hospitalization and acute Rehabilitation**

| |
|---|
| • *Nursing home* – includes facility charges with all other individually billed services assigned to relevant subcategories. |
| • *Attendant care* – in-home health care from a nurse, personal care attendant or paid family member. |
| • *Physician care* – outpatient physician visits and diagnostic testing. |
| • *Outpatient therapy* – outpatient physical, occupational, psychological and speech therapy. |
| • *DME* – includes items such as wheelchairs, beds, orthotics, exercise equipment, vehicle and home purchase or modifications. |
| • *Medications and medical supplies* – includes all medications and supplies (eg catheters, gauze, gloves) used outside of a hospital/in-patient rehabilitation setting. |
| • *Readmission* – hospital or rehabilitation readmission for SCI-related conditions. Routine urology, orthopedics, physiatry and neurology evaluations were not included in this category. The payments included all payments for services provided except DME and were compiled from date of readmission to date of discharge. |
| • *Case management* – case manager or management consultant charges. |
| • *Transportation* – car service, ambulance transport and travel reimbursement that occurred at any time other than the initial acute/rehabilitation admissions or readmissions. |
| • *Vocational rehabilitation* – includes funding for job retraining, computer skills and vocational-learning equipment. |

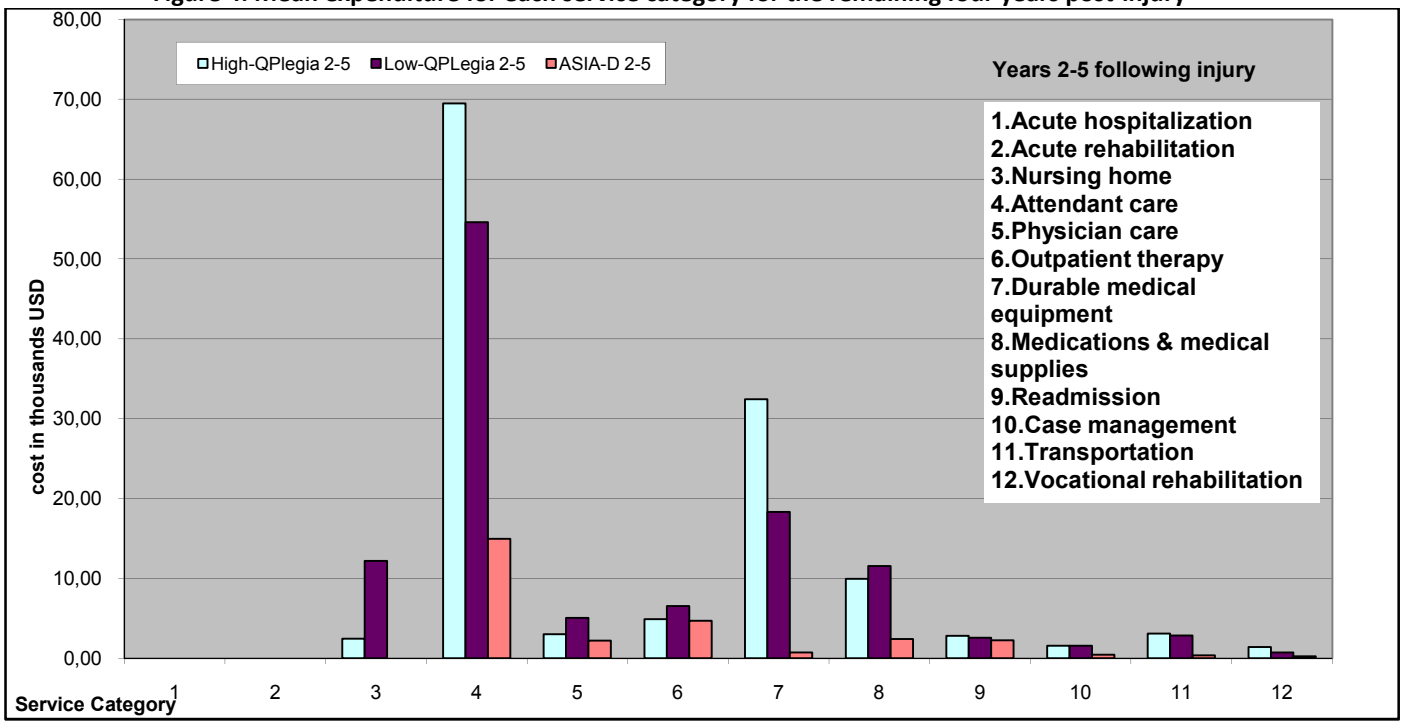
**SOURCE**: (Young et.al, 2004)

**Figure 3: Mean expenditure for each service category for the first the 1st year post-injury**




**SOURCE**: (Young 2004)

**Figure 4: Mean expenditure for each service category for the remaining four years post-injury**

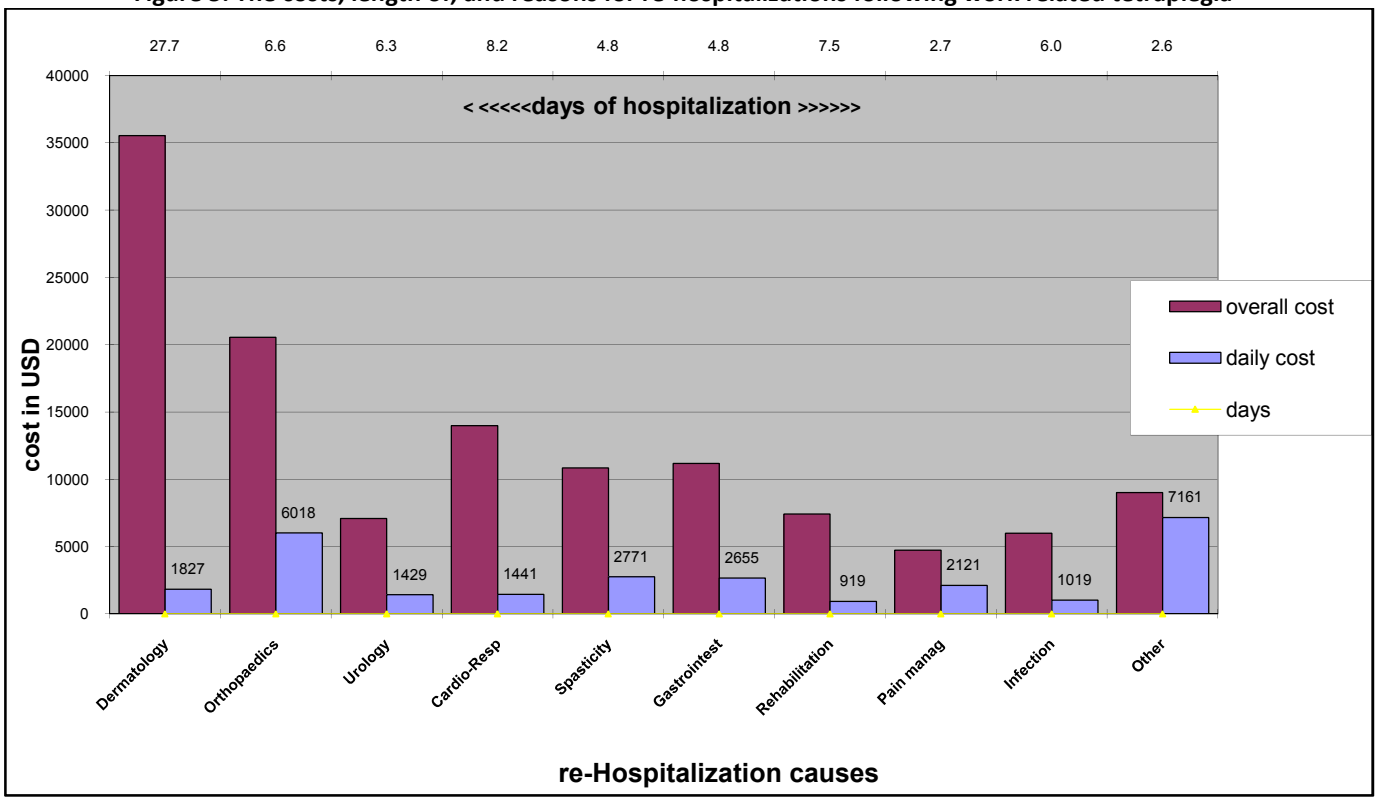



**SOURCE**: (Young 2004)

## 2.3 Re-Hospitalization

The resulting physiologic changes after SCI and hospitalization, can increase lifelong susceptibility to secondary health problems, which can lead to re-hospitalization. Re-hospitalizations are a significant cost to patients and society, with estimates from 1987 indicating that the median cost per re-hospitalization was $9.683 (Davidoff 1990). Research investigating re-hospitalization following SCI, has found that the reasons for re-hospitalization varied and most commonly include evaluation and care of urinary tract disorders, treatment of cardio-respiratory disease, neurological disorders, orthopaedic problems and soft tissue care (Young 2006), (**Figure 5**). The prevention of these conditions is central to addressing the issue of rates of re-hospitalization.

**Figure 5: The costs, length of, and reasons for re-hospitalizations following work related tetraplegia**




**SOURCE**: (A.E. Young et.al, 2006)

## 2.4 Outliers

In many cases, patients spend more than the average time of Hospitalization. These patients are defined as "Outliers" and their lengths of stay exceeds the mean length of stay for spinal cord injury patients by more than two standard deviations (Burnett 2000). Outliers took an average of 17.8 days longer to get to rehabilitation than non-outliers. They are atypical relative to the costs incurred to care for them on an inpatient unit and require extended use of inpatient staff and resources. Physicians and institutions can be enabled to focus their interventions and target resources for the needs of this patient population, if the risk factors could be identifying (Burnett 2000).

Many studies address medical complications, associated injuries and surgical procedures influencing lengths of stay for SCI patients; however, there has been very little emphasis on the economic impact of outliers. In a study of B. Webster et.al, 2004, estimated that when the major injury categories were compared (outliers removed), the mean Year 1 costs for high-tetraplegia and low-tetraplegia cases were not found to be significantly different from one another. However, both were significantly higher than the mean Year 1 costs for ASIA D cases ($P$<0.05). One reason to identify features of individuals who are length of stay outliers is to improve treatment efficiency, which ultimately serves to reduce cost (Burnett 2000).

## 2.5 Cost effectiveness

Economic evaluation is important as resources are scarce and choices must be made regarding their use (Drummond 1997).

Most of the health care systems are burdened by the heavy influence of economics rather than functional outcome. The optimal goal must be the improved care of the SCI patient by early identification of those in need of more extensive resources and improve the economic efficiency needed to provide maximal functional outcome.

There are no studies found, that considered both costs and the impact on patient outcomes of a given intervention (Bagnall 2003).

There are studies reported the length of hospitalization in an acute care or rehabilitation, or both and this could be an important outcome as it relates to costeffectiveness; however, the length of hospital stay may be more dependent on factors such as housing and level of support at home than on success

or otherwise of inpatient services. It may also relate to the level or complexity of the lesion. It is not possible to separate out this information from the included studies (Bagnall 2003).
The majority of the studies are cost analyses, cost of illness studies or cost function analyses, of limited use, because these types of studies are useful mainly to decision makers. On the other hand, economists have questioned whether they can be an aid to moving towards an efficient health care system (Byford 2000). For this purpose, both the costs and consequences of activities, in this case health care-related activities must be evaluated. This can be achieved using a large Randomized Control Trial, which fully consider the costs and consequences of implementing interventions (Bagnall 2003).

## 3. Conclusion

The way countries and their relevant organizations act on these cases of work related SCIs appears different. In the case of the European Union policy which addresses with multiple cultural and political member remarks, there's a need to design a baseline approach for the prevention – hospitalization – post injury cost coverage – pension and reaccession to the community. Also, there's need to consider the parameters mostly influences the cost outcome following SCIs, like the Hospitalization length of stay and its dependence of the quality of inpatient and rehabilitation services provided and the re-Hospitalization causes and the relative prevention must be taken.

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