

## Epidemiological Profile of Patients with Traumatic Cervical Spinal Cord Injury: A 5-year Tertiary Multicenter Retrospective Study

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### ABSTRACT

**INTRODUCTION:** The incidence of serious cervical spine injuries is low but associated rates of death and disability are high and is a devastating event for the patient and family. Mortality associated with cervical spine fractures is less studied. This deficiency in the literature contributes to a lack of consensus on the optimal treatment of cervical fractures.

**MATERIALS AND METHODS:** All patients admitted at Corazon Loecin Montelibano Memorial Regional Hospital, Negros Occidental, Philippines; Riverside Medical Center, Negros Occidental and Silliman Medical Center Negros Oriental, Philippines from January 2008 to December 2012 with cervical SCI secondary to trauma were included in the study. Charts of patients who met the inclusion and

exclusion criteria were collected.

**RESULTS:** The study group were mostly males ( $n = 51$ , 92.7%), with mean age of 43.67 years, with fall as the common cause of injury ( $n = 27$ , 49.1%), followed by vehicular accident, and axial loading. Majority had incomplete quadriplegia ( $n = 32$ , 58.2%), compared to complete quadriplegia ( $n = 23$ , 41.8%). Of the eleven mortalities (20%), 10 had complete quadriplegia- Frankel A (90.9%). Statistical analysis showed no significance between sexes ( $p = 0.8$ ), as well as the cause of injury ( $p = 0.659$ ) for mortality of the patient. Analysis however, showed a significant relationship of having complete quadriplegia, to eventual mortality ( $p = 0.001$ ). Last normal motor and sensory level, radiographic abnormality, presence of spinal shock on admission, and patient's age, showed no statistical significance to the mortality of the patient.

**CONCLUSION:** This study showed that males of older adult group with complete quadriplegia due to cervical SCI are statistically predictive of eventual mortality.

**Key words:** Cervical Spinal Injury, Mortality rate, Quadriplegia

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### INTRODUCTION

The incidence of serious cervical spine injuries is low but associated rates of death and disability are high. Cervical spine injury causes an estimated 6,000 deaths and 5,000 new cases of quadriplegia in the United States each year (Davinport, 2008)<sup>[1]</sup>. In both British and Chinese studies, cervical spine is the most commonly affected region among traumatic spinal cord injuries (Lenahan, 2012)<sup>[2,3]</sup>.

Cervical spinal cord injury (SCI) is a devastating event for the patient and family. It has a huge impact on society because of the intensive resources required to manage the patient in both the acute

and rehabilitation phases (Fielingsdorf, 2007)<sup>[4]</sup>. There has been so far, no definitive cure for spinal cord injury (SCI); therefore, the emphasis has been on prevention. The economy, social structure, politics and cultural tradition play important roles in the differences in incidence rates in different regions (Hong-Yong, 2011)<sup>[5]</sup>.

Mortality associated with cervical spine fractures is less studied. This deficiency in the literature contributes to a lack of consensus on the optimal treatment of cervical fractures (Jackson, 2005)<sup>[6]</sup>. Extensive studies have been done on spinal cord injury epidemiology; but there are limited studies focusing only on the cervical region particularly in the developing countries (Carlson, 2002) including the Philippines<sup>[7]</sup>.

### Objectives

This study aims to determine the demographics and profile of patients with cervical spinal cord injury secondary to trauma, the profile of fracture and/or dislocations, and the extent of paralysis among these patients, as well as the factors which may influence mortality in these patients.

Specifically, this will determine the demographics of the above patients according to age, sex, cause of injury, duration from injury to hospital admission, the extent of paralysis (complete vs. incomplete quadriplegia), the occurrence of fracture and/or dislocation with specific cervical spine level, the cause of death of these patients, and the rate of patients who underwent surgery and its outcome, and conservative treatment and corresponding outcome.

### Significance of the Study

This study will give local data on the epidemiological profile of patients with cervical spinal cord injury secondary to trauma. This will be of help to the medical practitioners especially the trauma physicians in prognostication of future patients with cervical SCI. It will also guide the physicians on in-patient care to decrease mortality rate among these patients based on their specific cause of death, and will help in setting future hospital guidelines on patients with cervical SCI.

## MATERIALS AND METHODS

All patients admitted at Corazon Locsin Montelibano Memorial Regional Hospital (Negros Occidental), Dr. Pablo O. Torre Memorial Hospital (Negros Occidental), and Silliman Medical Center (Negros Oriental), Philippines from January 2008 to December 2012 with cervical SCI secondary to trauma are included in the study.

Cervical SCI patients not secondary to trauma, patients who were not admitted or refused admission, trauma patients secondary to gunshot wound, and open cervical injury (e.g. hacking) are excluded in the study.

ASIA scoring was not included due to incomplete forms among some patients, and the type of study being retrospective, thus are its limitations.

Charts of patients who met the inclusion and exclusion criteria were collected. Data was gathered, collated, and described according to the set objectives.

Patients were categorized according to age as follows: children and adolescents (below 20 years), younger adult (20-39 years), older adult (40-59 years) and geriatric patients (60 years and above). After collection of data it was double entered in Microsoft Excel sheet and validated. A clean database was generated and copied into SPSS sheet. Then the whole data was analyzed using SPSS (version 16-0) software (IBM, Armonk, NY, USA). Categorical and continuous data were reported in the form of proportion and means  $\pm$  standard

deviation, respectively.

Terms used in this study include cervical spinal cord injury (SCI) which refers to any injury to the cervical spine, with varying symptoms (from pain to paralysis). Complete cervical SCI refers to total loss of function below the level of injury (Frankel A), while incomplete cervical SCI pertains to patients with total or partial preservation of motor or sensory function below the neurological level of injury, including SCI with completely normal motor and sensory scores (ASIA E). Trauma is defined as a physical injury, with amount of force applied to the body.

## RESULTS

During the 5-year period between 2008-2012 in 3 tertiary hospitals in the Negros island (both Occidental and Oriental), 73 records met the inclusion criteria, and 55 charts were found and reviewed.

The study group comprised of 51 males (92.7%), and 4 females (7.3%). Patients' age were from 15 to 76 years old, with mean age of 43.67 years ( $\pm 16.9$ , SD).

Common cause of injury in 27 patients was fall (49.1%), followed by vehicular accident sustained by 25 patients (45.5%), and axial loading in remaining 3 (5.5%). Incomplete quadriplegia was sustained by 32 patients (58.2%), and complete quadriplegia (Frankel A) in the remaining 23 patients (41.8%). Last normal dermatomal level for sensory and motor function was concentrated at the C4-C6 level, with highest at the C5 level ( $n = 17$ ; 30.9%).

Most of the patients sustained fracture-dislocations ( $n = 26$ ; 47.3%), followed with no radiographic abnormalities in 18 patients (32.7%), then with compression/burst fracture ( $n = 9$ ; 16.4%), and disk herniation ( $n = 2$ ; 3.6%).

Time from injury to hospitalization were on the extremes (1-2,160 hours, mean of 62.4,  $\pm 294.3$ , SD), as there were patients immediately rushed to the hospital within an hour, while there were patients, 2 in particular, brought at 18 days post injury while another came in 3 months post injury after failed repetitive traditional manipulations "hilot".

As for level of fracture-dislocations, most patients sustained at C5 over C6 vertebra ( $n = 18$ ; 69.2%), followed by C4 over C5 ( $n = 4$ ; 15.4%), and C6 over C7 ( $n = 2$ ; 7.7%), and one patient each in C1 over C2 ( $n = 1$ ; 3.8%), and C7 over T1 vertebra ( $n = 1$ ; 3.8%).

At the time of admission, no spinal shocks were noted in 29 patients (52.7%), while 26 had spinal shock (47.3%). During the course of treatment, 10 patients underwent surgery (18.2%), while the remaining 45 patients (81.8%) had conservative management. Operative fixation was done on stable patients with associated fracture or fracture-dislocations.

Eleven patients died in their hospital stay (20%), while 44 patients were treated and discharged (80%). Of the mortalities, most had complete quadriplegia- Frankel A ( $n = 10$ ; 43.5%), compared to incomplete quadriplegia ( $n = 1$ ; 3.1%). Most of them died within 1-2 weeks of hospital stay (mean = 10.36 days,  $\pm 12.94$ , SD). Cause of death was commonly due to respiratory arrest from the injury per se ( $n = 7$ ; 63.6%), and associated nosocomial pneumonia in the remaining patients ( $n = 4$ ; 36.4%).

Statistical analysis showed no significance between sexes for mortality based on chi-square tests (LRT = 0.064,  $df = 1$ ,  $p = 0.8$ ). Cause of injury did not also show statistical significance to eventual mortality ( $\chi^2 = 0.833$ ,  $df = 2$ ,  $p = 0.659$ ).

Analysis however, showed a significant relationship of the extent of paralysis and mortality ( $\chi^2 = 11.214$ ,  $df = 1$ ,  $p = 0.001$ ), as only 1 out of 31 patients with incomplete quadriplegia (3.1%) eventually expired, compared to 10 of 23 (43.5%) in completely quadriplegic

patients.

Last normal motor and sensory level did not show a significant statistical relationship to mortality (LR = 8.17, df = 6,  $p = 0.226$ ), as well as radiographic and/or MRI abnormality to mortality of the patient (LR = 1.19, df = 3,  $p = 0.753$ ). The presence of spinal shock on admission showed a significant relationship to the mortality (CC = 0.77, df = 1,  $p = 0.380$ ).

The age of the patient traditionally believed to predict mortality in cervical SCI cases, failed to show a significant relationship in this study (LR = 1.969, df = 3,  $p = 0.579$ ). Important to note however, that only 10.5% of patients in 20-39 years old bracket expired compared to 20-27% mortality rate in other age brackets.

Correlation of patient's age to the extent of paralysis (complete/incomplete) did not show a significant relationship (LR = 1.564, df = 3,  $p = 0.668$ ), as well as patient's sex (CC = 0, df = 1,  $p = 1.0$ ), and cause of injury (LR = 3.374, df = 2,  $p = 0.185$ ).

Cross-tabulation of extent of paralysis to mortality, and the presence of spinal shock revealed that patients with complete paralysis had greater chances of expiring compared to those with incomplete paralysis (10 out of 11 or 90.9%), regardless of whether he had spinal shock.

The association of surgery to the successfully discharged patients also showed a statistical significance ( $\chi^2 = 6.45$ , df = 2,  $p = 0.040$ ). This may be inconclusive, since clinically stable patients and with associated fracture or fracture with dislocations were operated. Other factors will also include economic situation of the family as well as consent for the procedure that may influence the rate of surgical intervention.

## DISCUSSION

There is scarce data on Philippine literature, particularly in Negros Island, on the study of cervical SCI. This is an area where about 3.7 million people reside, with poverty incidence of close to 24% according to 2011 Philippine Statistical Authority, and motorcycle is the main mode of transportation.

Results of this study showed patients mostly affected are at the older adult age group (40%, mean = 43.67 years,  $\pm 16.9$ , SD), also with the highest mortality age group (27.3%). This age group affected is close to a study in Tianjin, China (Ning, 2011)<sup>[8]</sup>, where mean age is at 48 years ( $\pm 16.9$ , SD). Considered as a transition from productive group to dependent age bracket, this group may not significantly hamper or affect the productivity of the region. This is in contrast with the Indian literature (Suvam, 2013)<sup>[9]</sup> with a mean of 33.5 years ( $\pm 12.8$  SD), where economic situation can be affected as it affects the productive age group.

Almost 93% of the patients were male in this study, as supported by almost all studies in the world (Lowery, 2001)<sup>[10]</sup>, (Ning, 2011). This may be attributed to the women in this island who are mostly homemakers, with less proportion of them going out, or performing activities at risk for fall, thus lesser chance of falls, or vehicular accidents.

The most common site of cervical spinal cord injury was at C5 level (30.9%) while fracture dislocations are highest at C5-C6 vertebrae (69.2%). This is in contrast to studies done by Brown *et al.*, where 68% was documented at C1-C4 level, and by Goldberg, *et al.*, where atlanto-axial joint was the common site. This was however supported by newer epidemiological studies (Jiao, 2010) where C5 is most commonly affected at 49.1%, and C4 at 29.5%. Indian studies done by Suvam, *et al.*, showed C3-C4 as the most common, followed by C4-C5 level<sup>[9]</sup>.

Common cause of injury was fall at 49.1%, closely followed by motor vehicular accident (MVA) at 45.5%. These patients usually sustained injury after climbing a tree or construction of a house. MVA on the other hand, is given owing to the main mode of transportation in the region. This data is also supported by a Chinese study by Wu, *et al* on 2012, where leading cause was fall (49.7%), followed by motor vehicle accidents (36.4%)<sup>[3]</sup>. Thus, a public policy, or at least a city/municipality ordinance should focus on fall prevention, as well as road safety seminars or information to lessen these cases.

Most patients of this study died within 1-2 weeks of hospital admission (mean = 10.36 days,  $\pm 12.94$ , SD). This can still be attributed to cervical cord edema, where vital functions might have been disturbed resulting to death. Numerous patients are also noted to be hospitalized a day after the injury. These are mainly patients from far flung areas, hardly reached by transportation. Some are also admitted at primary and secondary district hospitals and were eventually referred to these tertiary hospitals after some time. As mentioned, 2 extreme cases were noted who came in at 18 and 90 days post injury. It has been observed that many of these patients still believe on traditional ways of healing and different methods of traditional medicine, commonly performed by persons lacking any professional qualifications.

The most significant finding in this study is the relationship of extent of injury to mortality rate, with 43.5% of completely quadriplegic patients (Frankel A) eventually expired, compared to just 3.1% mortality rate for incomplete quadriplegic. Very few literature as of the present, support this association. A study in Shanghai, China (Shao, 2011) showed that patients with ASIA (Frankel) A, a high cervical SCI (C1-C3), and/or no surgical intervention were statistically more likely to have early mortality ( $p < 0.001$ )<sup>[11]</sup>.

A study in Nigeria (Kawu, 2011) showed a significant relationship of complete quadriplegia at time of admission to mortality ( $p = 0.001$ ), along with age ( $40.3 \pm 14.6$ ,  $p = 0.001$ ), and GCS  $< 9$  (RR = 14.6,  $p = 0.001$ )<sup>[12]</sup>. Study population however, included thoracic and lumbar areas. Another study done in Norway (Lidal, 2007), showed statistical significant relationship of complete quadriplegia to mortality (RR = 1.64,  $p = 0.012$ ) however, study subjects are not specified to cervical area only. A study done at South Africa (M terhaar, 2011) showed 20.4% of patients presented with complete quadriplegia (Frankel A), and MRI result showed significant association of intramedullary hemorrhage ( $p < 0.001$ ), cord swelling ( $p = 0.002$ ) and cord edema ( $p < 0.001$ ), which are eventually correlated with poor prognosis for neurological recovery<sup>[13]</sup>.

The significant relationship of survival rate of surgically treated patients in this study ( $\chi^2 = 6.45$ , df = 2,  $p = 0.040$ ) was supported by Shao *et al.*, as patients with no surgical intervention were statistically more likely to have early mortality ( $p < 0.001$ )<sup>[11,14]</sup>.

## CONCLUSION

This study showed that males of older adult group usually sustained cervical spinal cord injury either due to fall, or motor vehicular accident, with almost half having fracture-dislocation. Statistical analyses showed no significant relationship of age, sex, level of injury, and mechanism of injury to mortality. There is however a statistically significant relationship of extent of injury, particularly Frankel A, to eventual mortality of the patient. Surgical procedure can be a positive predictor for survival in cervical SCI patients.

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