# Incidence, circumstances, treatment and outcome of high-level cervical spinal fracture without associated spinal cord injury in New South Wales, Australia over a 12 year period

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A B S T R A C T

*Background:* No Australian population-based studies have examined temporal trends in the incidence of fracture of the first or second cervical vertebra (C1 or C2 fractures), their aetiology, treatment and outcome for younger (15–64 years) compared to older (65+ years) individuals. The aim of this research is to examine the circumstances, treatment and outcomes including mortality for C1 or C2 fractures without associated spinal cord injury by age group in New South Wales (NSW), Australia.
*Method:* A retrospective review of C1 or C2 vertebra fractures in individuals aged 15 years and over in the NSW Admitted Patient Data Collection from 1 July 1998 to 30 June 2010. Direct age standardised admission rates were calculated by cervical fracture type and by age group. Negative binomial regression was used to examine the statistical significance of changes in trend over time of hospitalised cervical fractures by age group.
*Results:* The annual rate of hospitalised C1 and C2 fractures without associated spinal cord injury for individuals aged 15 years and over in NSW was 2.3 per 100,000 population, with the rate estimated to increase by 5.3% each year. Those aged 85+ years had the highest rates of hospitalisation. For those aged 15–64 years, road trauma was the most common mechanism of injury, while for those aged 65+ years, a fall was the dominant mechanism of injury. The in-hospital mortality for individuals aged 65+ years was 11.8% compared to 0.7% for those aged 15–64 years.
*Conclusions:* This study identified an estimated increasing trend in C1 and C2 fractures over time, particularly for older individuals. While younger individuals are commonly injured in road traffic accidents, older individuals are predominantly injured following a fall. Injury prevention strategies should be targeted to the different age groups and injury mechanisms. Implementation of effective falls prevention strategies is likely to reduce these injuries in older people whilst road and vehicle safety including vehicle rollover protection standards may improve rates in younger people.

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## Introduction

Injuries are a significant public health issue with around five million injury-related deaths worldwide each year.[1] Injuries, while largely preventable, are one of the leading causes of death and of hospitalisation in Australia [2,3] and leave many individuals with severe disabilities that affect their quality of life and often require long-term health care.

Injuries to the vertebrae comprising the spine with or without cord involvement are a group of injuries seen across all age groups and are associated with significant burden, in terms of both debilitation and financial cost to the individual.[4–6] For vertebral injuries, the two most common injury mechanisms are high energy road traffic crashes and low energy falls.[7,8]

There is already significant body of literature that considers the causes and consequences of cervical cord injury in people of all ages.[6] However, injury of the cervical cord is a relatively uncommon injury, associated with approximately 7% of all cervical spine fractures.[8] Cervical spine fracture without spinal cord injury is considerably more common, particularly in older people, yet is less well studied in the literature. There is some evidence that cervical spine fracture of itself is associated with significant

mortality[9–11] with one study reporting a 22% in hospital mortality rate among older patients even in the absence of any associated spinal cord injury.[7] This study, which specifically looked at people aged 65 years and older, also demonstrated no difference in other poor outcomes including admission to a residential aged care setting between those who did and did not have associated spinal cord involvement.[7]

There have been no Australian population-based studies that have examined trends in the incidence of cervical spine fracture without cord injury, including aetiology, treatment and outcome for younger and older individuals. While there are likely to be similarities in terms of the overall nature of the causal event, sections of the population are likely to experience differences in aetiology, treatment and outcomes following a fracture of the cervical spine.[7,8] Understanding these differences is important in terms of choice and design of preventive initiatives and treatment provided.

This research aims to examine, in a population-based sample, the circumstances, treatment and outcomes including mortality for fractures of the first or second cervical vertebra, without spinal cord injury, for those aged 15–64 years and 65 years and older in New South Wales (NSW), Australia.

## Materials and methods

A retrospective epidemiological review of all hospital admissions of NSW residents was conducted using information recorded in the NSW Admitted Patient Data Collection (APDC) during 1 July 1998 to 30 June 2010.

### Data source

Data from the NSW APDC include information on hospitalisation for individuals from NSW public and private hospitals, private day procedures, and public psychiatric hospitals. Included are data on episodes of care in hospital, which end with the discharge, transfer, or death of the patient, or when the service category for the admitted patient changes. Information collected includes patient demographics, source of referral, injury circumstances, diagnoses, clinical procedures, and discharge destination. The hospitalisation diagnostic, external cause, location and activity data were coded using the International Classification of Disease, 10th Revision, Australian Modified (ICD-10-AM).[12]

Fractures of the first or second cervical vertebra (i.e. C1 or C2) where the patient was admitted to hospital were identified using the following criteria: (i) the hospitalisation was for a patient who was a resident of NSW and aged 15 years or older, and (ii) the

principal diagnosis was coded as 'fracture of first cervical vertebra' or 'fracture of second cervical vertebra' (i.e. ICD-10-AM: S12.0 or S12.1). Individuals who also had concussion were identified if one of the 21 available diagnosis classifications indicated the individual suffered concussion (i.e. ICD-10-AM: S06.0). Patient outcome following C1 or C2 fracture was assessed broadly using procedure performed, length of stay in hospital and discharge destination.

### Data management and analysis

Hospitalisations relating to transfers (i.e. transfers between hospitals) or statistical discharges (i.e. changes in the service category, such as a change from acute care to rehabilitation for a patient during one episode of care in a single facility) were excluded from the APDC in order to attempt to partly eliminate 'multiple counts'.

Analysis was performed using SAS version 9.1.[13] Age- and sex-specific population estimates at 31 December of each of the years under study, which corresponds to the mid-point of each financial year of APDC data, were obtained from the NSW Ministry of Health. These estimates were extrapolated from Australian Bureau of Statistics (ABS) population estimates at 30 June.[14] Direct age standardised rates were calculated using the estimated Australian residential population at 30 June 2001 as the standard population. Ninety-five per cent confidence intervals (95% CI) were calculated assuming a Poisson distribution.[15] Because of over-dispersion, negative binomial regression was used to examine the statistical significance of changes in the trend over time in the incidence of hospitalisation for fractures of the first or second cervical vertebra.[16] To examine the association between age group and injury mechanism and activity and location at time of injury, chi-square tests of independence were used.[16] Injury mechanism was grouped into seven categories for the chi-square test (i.e. road trauma, water transport, falls, exposure to inanimate mechanical forces, other injury mechanisms (including air transport, exposure to animate mechanical forces, drowning and submersion, self-harm, assault), and unspecified injury mechanisms). In addition, the age of one individual was not known, therefore this individual was excluded from age-specific comparisons in all data analyses, but the individual was included in total counts.

## Results

There were 1973 individuals aged 15 years and older who were admitted to hospital with a principal diagnosis of a C1 or C2
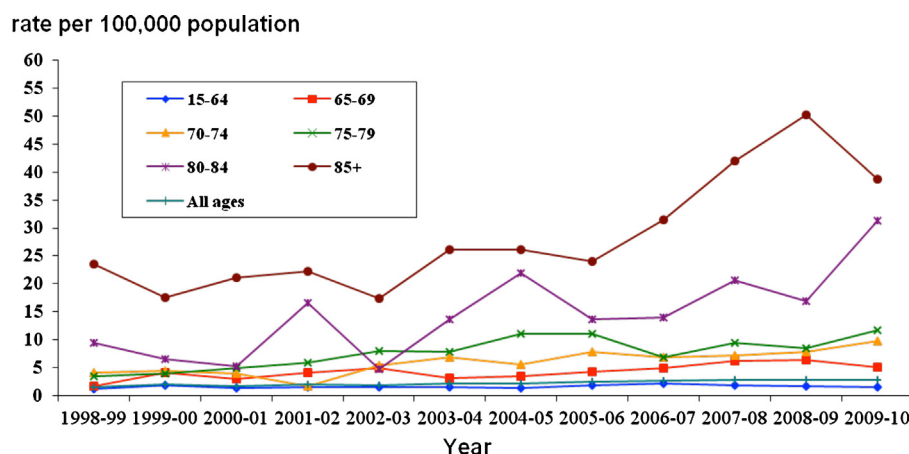


**Fig. 1.** Incidence rate of NSW residents aged 15 years and over hospitalised with a C1 or C2 fracture by year and age group, 1998–1999 to 2009–2010.[1,2] Age-standardised rate per 100,000 population.[2] Excludes 1 missing age from the calculation of age-standardised rates.