Injury, Int. J. Care Injured 44 (2013) 1514–1520

Contents lists available at SciVerse ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Patterns of healthcare service utilisation following severe traumatic brain injury: An idiographic analysis of injury compensation claims data

A. Collie [a,b,*], K-H. Prang [a]

[a] Institute for Safety Compensation and Recovery Research, Monash University, Australia
[b] Department of Epidemiology and Preventive Medicine, Monash University, Australia

ARTICLE INFO

Article history:
Accepted 10 March 2013

Keywords:
Brain injury
Transport
Idiographic
Health service use
Trajectory

ABSTRACT

Background: The rate and extent of recovery after severe traumatic brain injury (TBI) is heterogeneous making prediction of likely healthcare service utilisation (HSU) difficult. Patterns of HSU derived from nomothetic samples do not represent the diverse range of outcomes possible within this patient group. Group-based trajectory model is a semi-parametric statistical technique that seeks to identify clusters of individuals whose outcome (however measured) follows a similar pattern of change over time.
Aim: To identify and characterise patterns of HSU in the 5-year period following severe TBI.
Methods: Detailed healthcare treatment payments data in 316 adults with severe TBI (Glasgow Coma Scale score 3–8) from the transport accident compensation system in the state of Victoria, Australia was accessed for this analysis. A semi-parametric group-based trajectory analytical technique for longitudinal data was applied to monthly observation counts of HSU data to identify distinct clusters of participants' trajectories. Comparison between trajectory groups on demographic, injury, disability and compensation relevant outcomes was undertaken.
Results: Four distinct patterns (trajectories) of HSU were identified in the sample. The first trajectory group comprised 27% of participants and displayed a rapid decrease in HSU in the first year post-injury. The second group comprised 24% of participants and showed a sharp peak in HSU during the first 12 months post-injury followed by a decline over time. The third group comprised 32% of participants and showed a slight peak in HSU in the first few months post-injury and then a slow decline over time. The fourth group comprised 17% of participants and displayed a steady rise in HSU up to 30 months post-injury, followed by a gradual decline to a level consistent with that received in the first months post-injury. Significant differences were observed between groups on factors such as age, injury severity, and use of disability services.
Conclusions: There is substantial variation in patterns of HSU following severe TBI. Idiographic analysis can provide rich information for describing and understanding the resources required to help people with TBI.

Introduction

Traumatic brain injury (TBI) can result in substantial and lifelong cognitive, physical and behavioural impairments that necessitate long-term access to healthcare and disability services.[1] The rate and extent of recovery after TBI is heterogeneous making prediction of likely healthcare service utilisation (HSU) difficult. Provision of health and disability services to those with severe TBI is a major cost for health and injury compensation systems.[2]

Several studies have examined the overall pattern of post-injury or post-acute HSU following TBI in groups of patients.[3–6] There are fewer studies that have examined the intensity and type of post-TBI healthcare services provided.[2] Health service use increases with TBI severity and is greatest in the first year post-injury[7] but that substantial HSU persists for at least 5 years post-injury.[2] Such nomothetic studies typically collect data from a large population on a small number of occasions.[8] These studies provide insight into the overall patterns of HSU in groups of patients but are unable to describe individual characteristics and growth patterns,[9] or patterns of HSU in sub-groups of patients. TBI is a heterogeneous condition with potentially very different recovery trajectories at an individual patient level.[1] Some patients with severe TBI incur serious lifelong disability while others may recover many of the

* Corresponding author at: Level 11, 499 St Kilda Road, Melbourne, VIC 3004, Australia. Tel.: +61 3 9903 8604; fax: +61 3 9097 0699.
E-mail address: alex.collie@monash.edu (A. Collie).

0020–1383/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.injury.2013.03.006

pre-injury cognitive and physical functions affected by the injury. The heterogeneous nature of recovery post-TBI makes generalising HSU patterns from nomothetic samples problematic, as overall patterns do not represent the diverse range of outcomes possible within this patient group.

Idiographic (individual or patient level) analysis of HSU offers a potential solution. In contrast to the usual nomothetic approach, idiographic approaches seek to collect data on individuals on a large number of occasions.[9–11] It is then possible to describe and categorise different 'patterns' of outcome using statistical methods. Establishing patterns of HSU following severe TBI would provide insight into the different recovery trajectories following injury, provide a basis for healthcare service planning, and provide much richer information for describing and understanding the resources required to help people with TBI One statistical method that allows idiographic analysis is a time series based typology (using cluster analysis) that statistically categorises individuals into a 'group' or 'pattern' based on the observed pattern of outcome over time. This approach has been applied, for example, in a study of daily cigarette consumption following a smoking cessation intervention.[8] There are, however, methodological issues with time series analysis when one is dealing with HSU data. Instances of 'zero counts' (that is, days or weeks in which there was no HSU) which are common in HSU data make it difficult to calculate auto-correlations with previously observed time points in the dataset. This results in an inability to estimate an appropriate cluster model. It is possible to use different techniques such as deletion, mean substitution and maximum likelihood estimation to deal with such missing data,[12] however these approaches do not fully account for the zero counts.

An alternative method that provides a statistical solution to datasets that contain missing values is a group-based trajectory model.[13–15] This is a semi-parametric statistical technique used to analyse longitudinal data that seeks to identify clusters of individuals whose outcome (however measured) follows a similar pattern of change over time. Group-based trajectory modelling has been used to examine outcomes following whiplash injury,[16] substance use[17,18] and in mental health conditions.[19]

A recent study by Prang and colleagues[2] utilised detailed injury compensation system treatment payment data to describe patterns of HSU in the 5-year period following transport-related TBI. In jurisdictions with lifetime care injury compensation systems, treatment payment data provides an opportunity to examine in detail patterns of HSU following injury using statistical techniques such as trajectory analyses. The present study sought to identify and characterise trajectories of HSU in the 5-year period following severe TBI using detailed healthcare treatment payments data from the transport accident compensation system in the state of Victoria, Australia.

Methods

Transport injury compensation system

In the state of Victoria, Australia, those injured in transport accidents are eligible to claim compensation for treatment, income replacement, rehabilitation and long-term support services through the state transport injury compensation insurer, the Transport Accident Commission (TAC). Compensation is provided regardless of fault, and covers the reasonable costs of healthcare treatment and rehabilitation. There are maximum fees for most services. Healthcare services to which the TAC provides funding for accident injuries include: ambulance services, hospital services, medical services, pharmacy items, and paramedical or allied health services.[20]

Participants

HSU and other data for this analysis was extracted from the injury compensation claims records of the TAC contained in the Compensation Research Database (CRD) established by the first author. Information on the CRD has been described in a previous study.[21] Three hundreds and sixteen adults (18–65 years of age) with severe TBI (defined as a Glasgow Coma Scale (GCS) score between 3 and 8) resulting from transport-related accidents occurring between 1 January 1995 and 31 December 2004 were included in the study. Participants were a subset of a previous study.[2]

Data analyses

Data extracted from the CRD consisted of daily observation counts of individual episodes of medical and allied healthcare services in the 5-year period post-injury. Services provided in hospital, pharmacy and ambulance services were excluded from the analysis. Data was then limited to those episodes of HSU where there was a patient–provider interaction. This included consultations with doctors such as General Practitioners (GPs), specialists, physicians, as well as services provided by allied health practitioners such as psychiatrists, dentists, psychologists, speech therapists, social workers, physiotherapists, chiropodists, podiatrists, optometrists, chiropractors, osteopaths, occupational therapists, acupuncturists, and counsellors. In practice this involved excluding healthcare service payment records that did not involve a patient-service provider interaction (e.g. pathology testing, fees for radiology services, reimbursements paid by the TAC for the patient to travel to and from healthcare appointments). These daily observation counts were then converted to monthly observation counts by simple summation, providing a total of 60 observations for each participant in the sample. Monthly counts of HSU were transformed by square rooting to avoid correlation of polynomial coefficients. Very high mean HSU counts were observed in the first two months post-injury. These high counts limited the ability of the trajectory model to fit a curve to observed data and thus were excluded from analysis. The time post-injury was recoded so that the central observation (month 31) centred at zero.

A semi-parametric group-based trajectory analytical technique for longitudinal data developed by Nagin[13] was used to identify distinct clusters of participants' trajectories. SAS version 9.2 and the SAS-based procedure PROC TRAJ, written by Jones, Nagin and Roeder[14] were used for the analyses. Alpha levels of 0.05 were used to determine statistical significance. The Censored Normal Model Distribution (CNORM) was selected as the most appropriate model for the available data. The next step was to determine the optimal number of trajectory groups and the shape (polynomial parameters) of trajectories, as per the process described by Nagin.[13] This involved iterative expansion of the model starting with a single group model and proceeding until a five group model was fitted. For each model and for each group, the highest order of polynomial (quintic) was fitted first. If the higher-order polynomial parameters were not significant, we excluded those higher-order parameters and refitted the model with the next highest polynomial parameters (quartic, quadratic, linear or intercept). The Bayesian Information Criterion (BIC) was used to select the best model by comparing the fit of each model. The model with the largest BIC (the least negative BIC value) was considered to be the best fit.

In addition, the posterior probabilities (estimation of the probability that each participant is a member of each modelled trajectory) were calculated based on the maximum posterior probability assignment rule. The maximum posterior probability assignment rule assigned each participant into a specific trajectory