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Why Statistical Modelling in Outcome Prediction in Patients with Traumatic Brain Injury is Essential?: In Indian context

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Abstract

Traumatic brain injury (TBI) is a significant public health problem in all regions of the globe despite advancement in prevention and treatments. Its global incidence is rising and it is predicted to surpass many diseases as a major cause of death and disability by the year 2020. It is a leading cause of mortality, morbidity, disability, and socioeconomic losses in India as well. For reducing the burden of TBIs, India and other developing countries are facing the major challenges of prehospital care, prevention, and rehabilitation in their rapidly changing environments.

Keywords: Traumatic brain injury; Public health; Diseases; Patients; Head injury

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In case of TBI or head injury, prognosis is a fundamental responsibility of all clinicians like diagnosis and treatment, where uncertainty about the future compounds the suffering already experienced by patients and families. Indeed, families have identified information about future outcome in case of TBI as one of their most important needs. This necessity often goes unmet, as families reported that they were rarely provided sufficient prognostic information [1-5].

Clinical prediction models are statistical models that combine a number of characteristics (e.g., related to the patient, the disease, or treatment) for predicting a diagnostic or prognostic outcome [6]. For evaluating trauma care, a statistical model is a powerful tool [7]. In case of TBI, there are numerous factors that may affect outcome. Statistical modelling has been used for prognostication, hypothesis generation and stratification of patients in various TBI related studies [8]. Prognostication can assist in rationalized transfer of patients to neurosurgical specialist services, advising patient's relatives about future outcome(s), and initial management of an individual patient. Most of the predictive values in such models are made up of relatively few predictors (age, pupillary reactivity, motor score, hypotension, and CT features). Adding further predictors are not useful in models that can already misrepresent outcome in a patient.

There are ample reports in the literature that shows association/correlation of a particular clinical parameter or biological marker with outcome(s) using bivariate analysis. In many of these reports, it is assumed that if a parameter correlates with outcome then it is somehow involved in the pathogenesis of traumatic brain injury. The use of bivariate analysis in this way is fundamentally false. In any complex biological system there is a web of complicated interrelationships among biological parameters. Statistical models can be used in the stratification of patients as well in clinical trials as a method of compensating for the inherent heterogeneity of the TBI population. Therefore, we can say that the intelligent application of statistical models can improve our understanding of the pathology, prognosis and treatment in case of TBI [8].

From statistical point of view, the literature does not provide evidence to state that a particular method of developing prognostic or statistical model performs better as compared to other models, as they were derived in different settings using different variables. The review of literature revealed that choice of a particular method of developing statistical model in TBI seems to be most often based on the needs of the specific application, rather than on the premise that any one of these method is intrinsically more powerful. Titterington et al. demonstrated that it was the choice of variables and the setting in which they were applied which is more important rather than the formulae [9]. The importance of specific predictors may vary among different centres, and the inclusion and exclusion criteria are also variable.

As many of the models are based on western setting or population, it may not be well suited for TBI population of developing nations [10]. In TBI, statistical or prognostic models are frequently published but most are developed from small samples of patients, particularly in developing countries, their methodological quality is not so good and they are rarely validated externally. Furthermore, as models are not presented to clinician in a user friendly way, they are not clinically useful. Finally only a few are developed using patients from low and middle income countries, where burden of the trauma is very high, the generalizability to these setting is limited [6]. In the field of TBI, existing literature show that very few studies has been done in Indian context. For policymaking, there is a lack of reliable and larger data regarding TBI in this setting [3]. For fulfilling this gap, first study of its kind from the Indian subcontinent was done by us that gave data on the admission characteristics, mortality and 6 months outcome of such patients [11].

In brief, in case of TBI, the application of a statistical model to a new data set is only valid if this new data set has a similar distribution of factors related to outcome, when consider in combination, as that which existed in the set from which the model was derived. Jai Prakash Narayan (JPN) Apex Trauma Centre, All India Institute of Medical

Sciences (AIIMS), New Delhi (India) is the largest tertiary trauma care center in our setting and it is currently working as one of the best integrated level 1 trauma centers in India. This center has a large data set, which consists of many characteristics. Now it is the right time to develop our own models and make comparison for evaluation of outcome after trauma brain injury (TBI).

For prognostic models in TBI, logistic regression method is applied most often but recursive portioning with construction of prediction tree may be attractive to clinicians because of simple presentation. Neural networks are becoming more popular due to their flexibility to predict the outcome when the relationship between the variables is complex, multidimensional, and nonlinear. Many found similar performance of neural network and logistic regression model. All these techniques might be used and explored parallel in the future. From the review of many articles, it is evident that there is no study which has used a common data set to compare the prediction performance of Logistic Regression, Classification and Regression Tree, and Artificial Neural Network for predicting outcome(s) in patients with TBI. So, our attempt was to derive statistical models based on variables available at the time of admission at our center and well suited for our setting to predict outcomes in patients with TBI [12].

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