

A systems approach to monitoring trauma system performance

Rod McClure^a, Jason Thompson^b, Behrooz Hassani-Mahmooei^c

^a Harvard Injury Control Research Center, Harvard School of Public Health, Boston, USA; ^bMelbourne School of Design, University of Melbourne; ^cInstitute for Safety, Compensation and Recovery Research (ISCRR)

Abstract

With the goal to provide the basis for future analytic studies we established a set of equations using integral calculus that could be used to monitor whole-of-system effectiveness of trauma systems. We report, for a given external cause category (ie road traffic injury), the descriptive epidemiology of trauma in all six states of Australia from 2000 to 2015, to demonstrate time trends in severe injury and deaths in the context of changes to societal level factors observed in the pre injury, acute care and rehabilitation environments.

Background

Trauma systems function within the public health framework as “a pre-planned, comprehensive, and coordinated statewide and local injury response network.” (HRSA 2006:1) Their goals are “to reduce the incidence and severity of injury as well as to improve health outcomes for those who are injured.” (HRSA 2006:3) The continuum of care is an excellent conceptual model, however its scope crosses boundaries of physical and social environments, organizational and professional structures, lines of funding and responsibility, and ownership and access to data. As a result, the whole system is rarely visualized or operationalized in its entirety. While it might not be necessary to formalize a single governance and funding structure for the entire injury system, it is important to undertake a whole-of-system evaluation. This is because, analogous to biological results observed *in vitro* versus the observed *in vivo* effects, the overall performance of a trauma system cannot be anticipated on the basis of known behaviors of its component parts.

Methods, Results & Discussion

Each of the trauma performance indicators was described for Australia by state and year. A qualitative model was developed representing the continuum of population patient states with a trauma system. This qualitative model was quantified using integral calculus to provide mathematical representation of the injury continuum, in a manner that enabled a calculation of five performance indicators on the basis of algebraic functions derived from systemic component causes. Empirical data was obtained relating to the prevalence of the systemic factors, and the known associations between these factors and trauma system indicators. All empirical causal factor data, and trauma system outcome data were combined into one data set that was then split into two sets; one comprising even numbered years, the other being odd numbered years. The model was run on even year data, one year at a time, and the model’s constants set so that the model accurately results in the observed indicators. This final model was validated by running the model one year at a time for the odd numbered years and comparing the models estimated outcomes with the true outcome indicators observed for that year. The model was generalized for the entire study period by inserting summary values of the input data (eg annual percent increase in population over the study period, instead of year by year actual changes) and the model run as a simulation model to for a 14 year simulation to estimate trauma system outcomes over this period.

These analyses demonstrated a reliable, structured mechanism for bringing together data from multiple sources, and linking into mass social data systems on real time basis. The stocks and flows approach retains “memory” of the states within the modelled system so that the population under consideration is modelled to evolve, as real populations do, with the changes they undergo. Importantly it also provides the bridge to enable the application of systems-based analytic methods for population level public health analyses..

References

HRSA Model Trauma System Planning and Evaluation US Department of Human Services 2006.