Functional outcome after injury: Can it be predicted?

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Methods

- Target population: Injured persons admitted >24h
- Setting: Two trauma centres, Brisbane
- Design: Prospective cohort study
- Eligibility defined by:
  - Acute condition ICD-9-CM: 800.0 and 959.9
  - Included in the Queensland Trauma Registry
  - Admitted between 1 June 1998 – 1 December 1998
- Procedure:
  - Registry patients approached at hospital – information and consent obtained
  - Demographic, injury and predicted FCI info obtained
  - Between 12-13.5 months after injury, telephoned and current functional capacity obtained
Results – participant profile

- 1815 eligible
  - 791 (44%) invited to participate
  - 665 (84%) consented
  - 619 (93%) followed-up [617 having complete AIS info]

- 451 (73%) male

- Age (years): <20 (15%), 20-39 (41%), 40-59 (26%), 60-79 (15%), 80+ (4%)

- LOS (days): <7 (58%), 7-13 (22%), 14-20 (9%), 21-27 (4%), 28+ (7%)

- AIS codes assigned: median 2 range (1-17)
Results - FCI

- All but 30 (5%) could have ≥1 FCI code assigned
- Lots of numbers – lots of detail...

Validating the Functional Capacity Index: A Comparison of Predicted versus Observed Total Body Scores

Philip J. Schluter, BSc(Hons), MSc, PhD, Rachel Neale, BVSc, PhD, Deborah Scott, Dip Nurs, MPH, Stephen Luchter, BS, and Roderick J. McClure, MB BS, PhD

J Trauma. 2005;58:259–263.
## Results - FCI

- 61% with predicted impairment at 12-months
- 47% with impairment at 12-month follow-up

<table>
<thead>
<tr>
<th></th>
<th>Observed (at 12-months)</th>
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<tbody>
<tr>
<td><strong>Predicted</strong></td>
<td><strong>No impairment</strong></td>
</tr>
<tr>
<td>No impairment</td>
<td>136 (23%)</td>
</tr>
<tr>
<td>Impairment</td>
<td>177 (30%)</td>
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- Concordance in 54% of people
- Agreement poor kappa ($\kappa$) = 0.05 (95% CI: 0.00-0.10)
- Regression: 1% of observed variability explained
Conclusions - FCI

- FCI poorly predicted observed functional loss 12-months post-injury
- FCI systematically underestimated functional loss
  - Head injury patients
  - Multiple injured patients that included lower extremities

Without substantial refinement, the FCI appears to have little predicative capacity in this population
Can we do better than the FCI?

Instead of relying entirely on ‘expert clinical knowledge’ and anatomical AIS information

- Incorporate routinely collected demographics (age, gender) covariates (LOS, blood pressure, pulse at admission, respiratory rate at admission, temperature at admission, admitted to ICU, injury intention, operation) and comorbidities

- Carefully developed, sophisticated statistical methods and predictive techniques

AIM: To produce a scale with better predictive utility
Doing better than the FCI

- Developed predictive model – developed & assessed against Health Consequences of Injury Questionnaire (HClIQ) data
  - Cross-validation – successive hold-out samples
  - Assessed using proper Brier scoring rule

- Multivariable ordinal logistic regression modelling revealed:
  - lower extremity injury body region, ISS, age, LOS, pulse & admission to ICU all statistically important
  - No two-factor interactions were significant
  - Residual checks & influence diagnostics were satisfactory
  - Nagelkerke’s adjusted generalized $r^2=0.21$
Doing better – but is it good enough?

Details of data and modelling

ANZ J. Surg. 2006; 76: 886–893
doi: 10.1111/j.1445-2197.2006.03900.x

ORIGINAL ARTICLE

PREDICTING FUNCTIONAL CAPACITY OUTCOME 12 MONTHS AFTER HOSPITALIZED INJURY

PHILIP J. SCHLUTER* AND RODERICK J. MCCLURE†

Bottom line: Although carefully developed, this statistical model lacks the predictive power necessary for its use as a basis of a useful prognostic tool
Where next then?

My personal view:

- We are unlikely to yield adequate predictive models when ignoring individual’s psychological & emotional profile.
- Even with a broader collection of ‘individual’ characteristics, we are unlikely to yield adequate predictive models when ignoring household, community, regional networks, support and functioning.
- We need to move away from traditional epidemiological approaches to social epidemiological thinking.
- Develop hierarchical multi-level predictive models that embody multifaceted individual-level, community-level, & regional-level information.
Public health burden of injury

- Globally, injury is a leading cause of death & disability for all under 60 years of age [Peden et al. 2000 WHO]

- Global burden associated with preventable injuries is one of the main challenges for public health in the 21st century [Krug 2004 Lancet]

- In Zealand, injuries account for ≈1,600 deaths & 42,000 hospitalisations per annum; During 2002/03, over 1.5 million injury claims were accepted by ACC; NZ social & economic costs of injury NZD$6-7 billion per year [ACC 2003]
Trauma System performance

- Decreasing the number of preventable deaths – focus of trauma system quality control programmes

- Majority survive injuries – many experience disability up to 12 months post-injury


THOMAS KOSSMANN, MD, FRACS

COMMENTARY

THE NEED TO MOVE ON FROM MORTALITY TO MORBIDITY OUTCOME PREDICTIONS

Over the last 50 years trauma care has improved substantially. In particular the introduction of trauma systems with predefined structures, defined level of care, agreed triage and transport protocols has resulted in substantial improvements in mortality. With this improvement has also come an increased awareness of the continuing need to improve patient outcomes with survivors. This is often measured with outcomes related to patient function. One of the key areas that has not been addressed to the extent it should be is the requirement to improve the trauma system in terms of morbidity outcomes. Currently the focus of trauma systems is still skewed towards mortality outcomes which is an insensitive measure of the overall quality of trauma care. Through the expansion of trauma systems to include improved morbidity outcomes we will be able to provide a more comprehensive picture of the overall quality of our trauma systems.
Morbidity outcome predictions

Unlike injury severity scores measuring ‘threat-to-life’ - dearth of ‘threat-to-functional capacity’ measures


FCI maps 1990 Abbreviated Injury Scale (AIS) into scores reflecting EXPECTED levels of reduced functional capacity 1-year post-injury
FCI development

Developed in 3 steps:

- Expert clinical panel identified 10 dimensions of function (Excretory; Eating; Sexual; Ambulation; Hand/arm; Bending/lifting; Visual; Auditory; Speech; Cognitive) & defined levels of capacity within each (No limitation to maximum limitation)

- 114 individuals (24 with limitations) rated relative severity of different levels of functions in terms of impact on daily living

- Clinical experts assigned FCI scores to AIS descriptions based on their knowledge of likely 1-year consequences with each injury (body regions: head; face; neck; thorax; abdomen; spine; upper extremities; lower extremities)
FCI predictive score

- FCI scores derived: 0 (no limitation) – 100 (max limitation)
- FCI scores skewed and bi-modal/multi-modal so ordinal categories: 0; 1-20; 21-40; 41-60; 61-80; 81-100

The Development of the Functional Capacity Index

Ellen J. MacKenzie, PhD, Anne Damiano, ScD, Ted Miller, PhD, and Steve Luchter, BS

Objective: This paper describes the development of the Functional Capacity Index (FCI) and compares it to the Abbreviated Injury Scale (AIS) and the Injury Impairment Scale (IIS).

Results: Consistency of FCI scores derived within and across dimensions of function argue for the conceptual integrity of the index. Non-zero FCI scores were assigned to only 26% of the

- Two US validity studies showed promise & problems...
Current functional capacity

Two scales administered by telephone employed to measure patients current functional capacity 12-months post-injury

- Adapted FCI – again elicited over 10 dimensions to create a single score: 0 (no limitations) to 100 (maximum limitation) [MacKenzie et al. 2002 Qual Life Res]

- The Health Consequences of Injury Questionnaire (HClQ) [McClure 1995 Acad Emerg Med]
  - 3-page health status questionnaire, suitable for self-admin.
  - records health profile, ascribes Quality of Well-being (QWB) scale weights
    - 0 (maximum limitation) to 1 (no limitation)
    - good reliability and validity
Health Consequence of Injury (HCIQ)

The Health Consequences of Injury Questionnaire (HCIQ)

- Any physical, mental, emotional problem in last week due to nominated injury (Yes/No)?
- If Yes, specific questions – to determine area(s) and extent
- Included: issues or difficulties with pain, nausea, fatigue, depression, anxiety, concentrating, remembering, thinking clear as a result of the nominated injury (Yes/No responses)
- Series of questions within domains were then elicited for mobility (five questions), physical functions (six questions), major social role (three questions), minor social role (eight questions) and self-care (fourteen questions), (Yes/No/NA responses)
Study’s objectives

To determine the validity of the FCI in an Australian setting

That is: to see how well the predicted FCI scores agreed with those observed 12-months post-injury