

# 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  $\geq 1$  FCI code assigned
- Lots of numbers – lots of detail...

*The Journal of TRAUMA® Injury, Infection, and Critical Care*

## **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

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Predicted	Observed (at 12-months)	
	No impairment	Impairment
No impairment	136 (23%)	93 (16%)
Impairment	177 (30%)	181 (31%)

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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 (HCIQ) 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

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### ORIGINAL ARTICLE

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## **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 21<sup>st</sup> century  
[Krug 2004 Lancet]
- In Zealand, injuries account for  $\approx 1,600$  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
- ‘Preventable deaths’ now an insensitive measure of trauma system performance [Gabbe et al. 2005 ANZ J Surg]

ANZ J. Surg. 2005; 75: 623

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## COMMENTARY

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### 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, coordinated triage and transport systems

older than 75 years. By including certain comorbidities the survival can be better predicted.<sup>5</sup>

Gabbe et al. move into a new era of auditing trauma care



# Morbidity outcome predictions

- Unlike injury severity scores measuring 'threat-to-life' - dearth of 'threat-to-functional capacity' measures
- Functional Capacity Index (FCI) – developed by MacKenzie et al (1996) at John Hopkins
- 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

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## 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 (HCIQ)  
[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