

# *Improvements in the validity of ICD-based Injury Severity Scores (ICISS)*

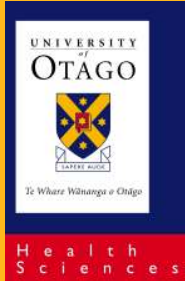
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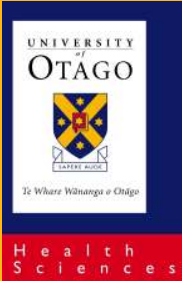
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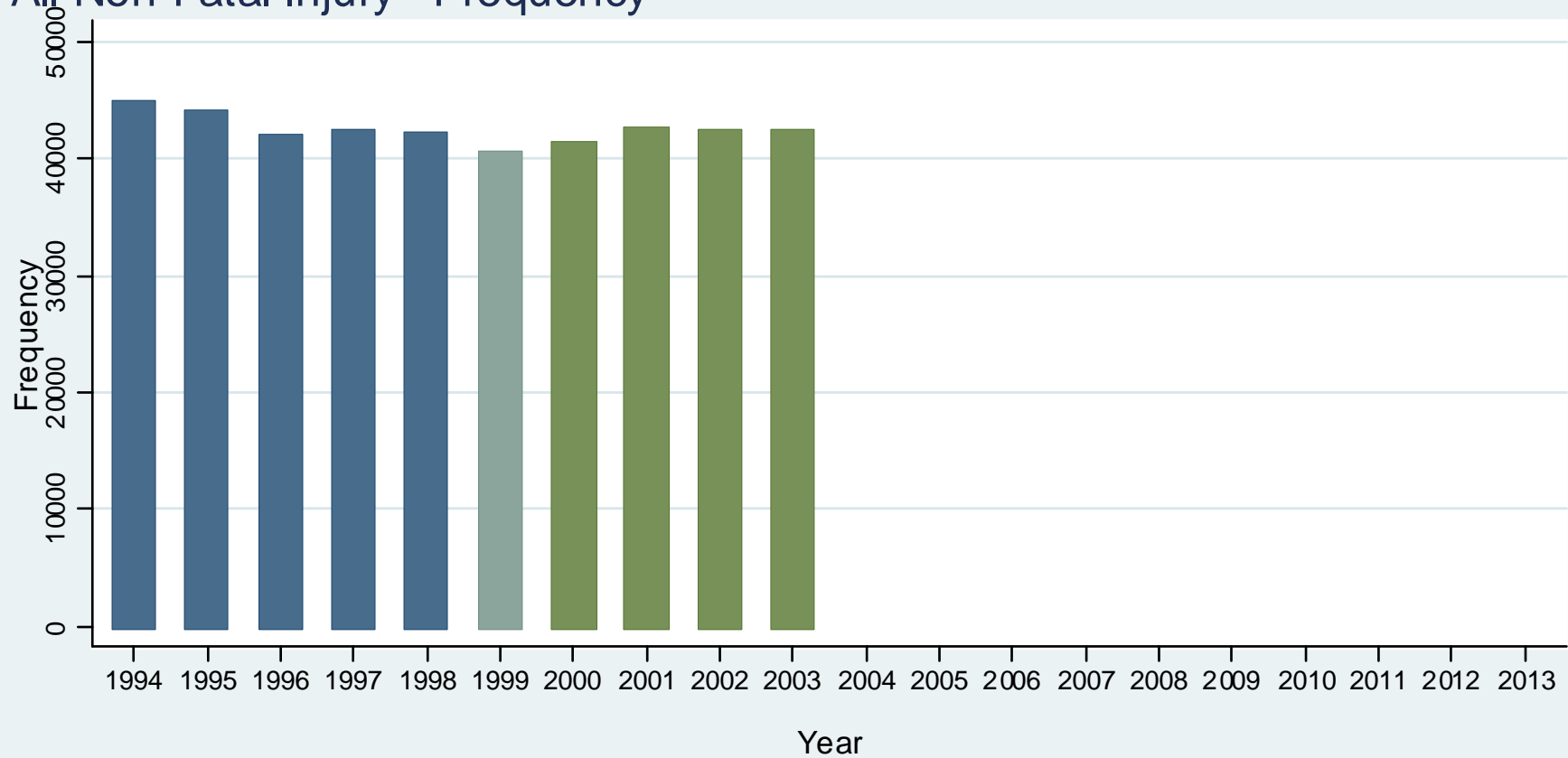
## Why?

- NZIPS & other Govt agencies assess their performance in reducing injury over time
- Need to reduce service-provision and access effects when monitoring trends in non-fatal injury
  - **Severity threshold**
  - **IPRU's development of "serious non-fatal injury indicators"**

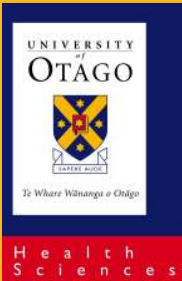


# Example - Hospitalisations

## All Non-Fatal Injury - Frequency

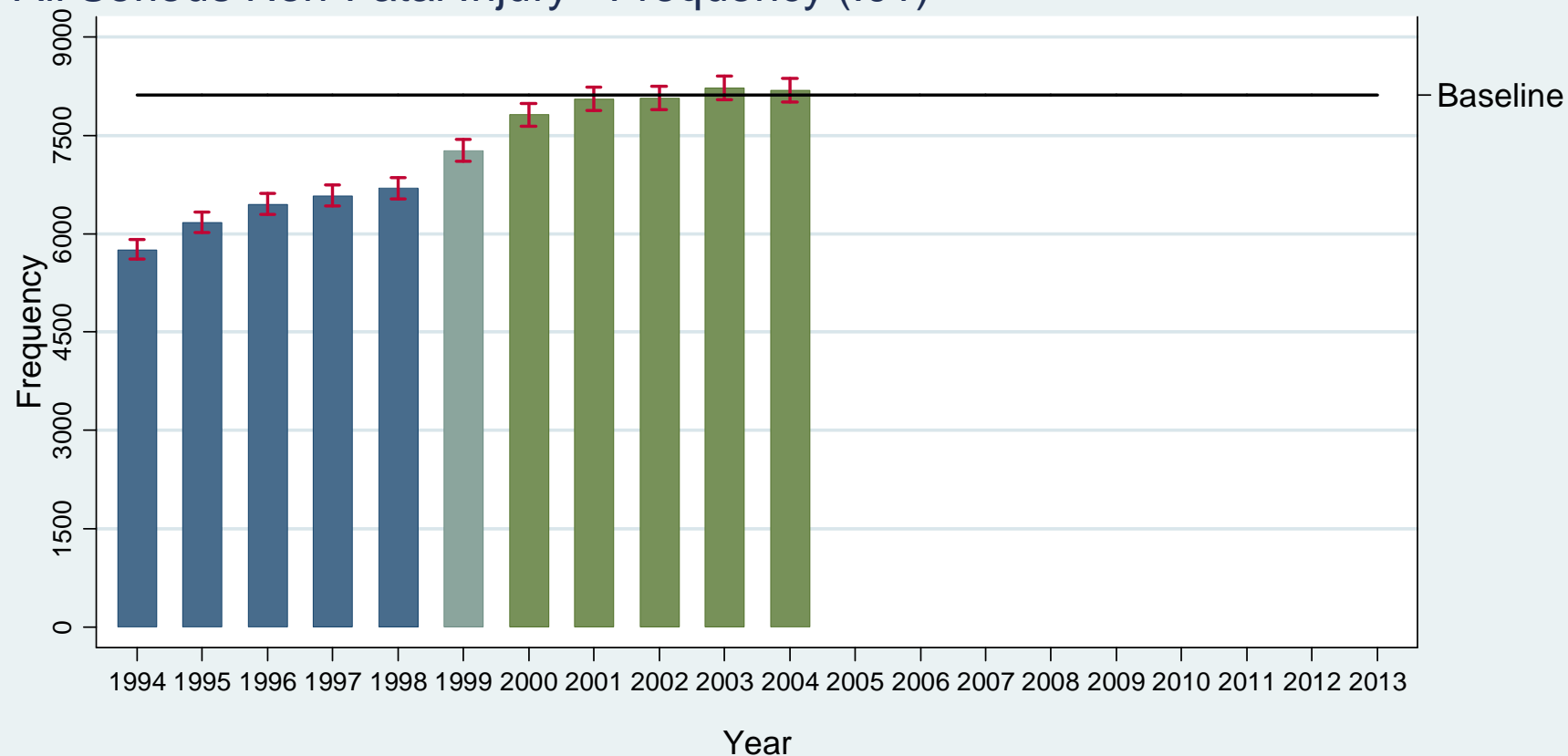


Note: 1999 data are affected by the changeover from ICD-9 to ICD-10.  
Source: New Zealand Health Information Service, National Minimum Data Set.

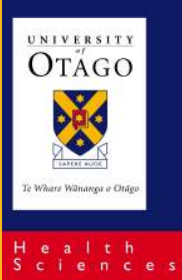


# NZIPS Indicator

## All Serious Non-Fatal Injury - Frequency (I01)

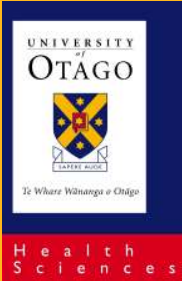


Note: 1999 data are affected by the changeover from ICD-9 to ICD-10. 2004 data are provisional.  
Source: New Zealand Health Information Service, National Minimum Data Set.



# *Relevance*

- **Valid measurement of injury severity is:**
  - critical to producing valid indicators
  - critical for the production of valid information to inform policy and injury prevention practice

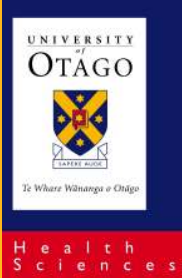


# What is ICISS?

- **ICISS = threat-to-life based injury severity score calculated from routinely collected ICD codes**
- ***To calculate ICISS....***

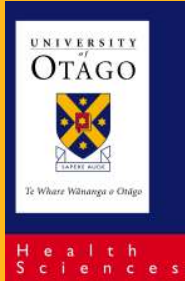
**First**, for each ICD diagnostic code, the proportion of people who are admitted and survived their injury to discharge was calculated – this is called the **Survival Risk Ratio (SRR)**

$$\text{SRR(A)} = \frac{\# \text{ hospitalisations with diag A discharged alive}}{\# \text{ hospitalisations with diag A}}$$



## *How ICISS is calculated*

- For people who have a **single diagnosis** (A) recorded,  
**ICISS=SRR(A)**
- For people who have **multiple diagnoses** (A, B, C etc.) recorded,  
**ICISS = SRR(A) x SRR(B) x SRR(C) x ... x SRR(N)**
- **ICISS = estimated survival probability**



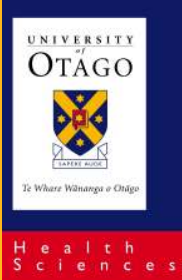
# *Definition of a serious non-fatal injury*

**If ICISS  $\leq$  0.941 = Serious non-fatal injury**

- Includes cases with an estimated probability of death of 5.9% or greater
- Only includes cases of injury that have a very high likelihood of admission to hospital

Examples:

- Fracture of the neck of femur
- Intracranial injury (excluding concussion only cases)
- Injuries of nerves and spinal cord at neck level



# Research Aim - 1

Can we improve the predictive ability of ICISS by....

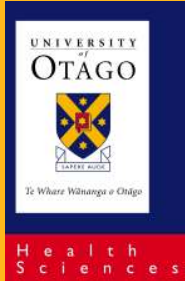
- Using both NZHIS Hospitalisations & Mortality data in ICISS calculation

ICISS as currently used estimates

*Survival to hospital discharge given admission*

Adding all deaths would, in theory, better reflect

*Threat to life*

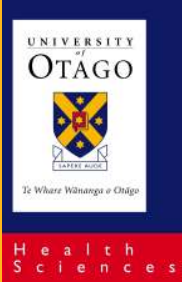


## *Research Aim - 2*

Can we improve the predictive ability of ICISS by....

- **Accounting for comorbidity**

Is it possible/useful to include comorbid conditions in ICISS calculation?



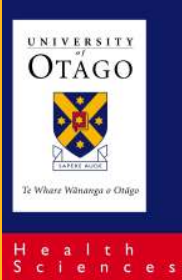
# *Mortality diagnoses*

## Inclusion of non-hospitalised injury deaths

- Have diagnoses coded Mortality data from 2000 on
- **Quality of mortality diagnoses?**

For those that died in hospital, compared diagnoses in Hospitalisation & Mortality datasets:

- ➔ Illustrated that recording and coding of non-hospitalised deaths is different to that for deaths occurring in hospital
- ➔ Used hospital diagnoses for this subset



# Comorbidity

## Inclusion of comorbidity

- **Harborview Assessment for Risk of Mortality (HARM)**

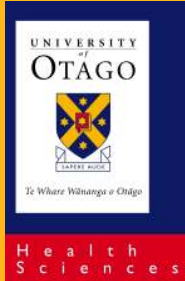
11 comorbid conditions:

COPD, Congenital coagulopathy, Diabetes, Cirrhosis, IHD, Hypertension, Psychoses, Epilepsy, Obesity, Alcohol or drug dependence, Neurological degenerative disease

- **Charlson Comorbidity Index (CCI)**

17 comorbid conditions:

Similar to HARM comorbid conditions but includes AIDS, Cancer, Connective tissue disease and doesn't include Epilepsy or Obesity



# Comorbidity SRRs

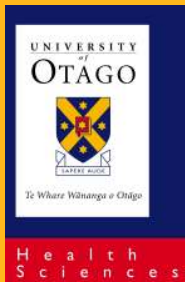
Comorbid SRRs were calculated at 2 levels:

**Variable** – one SRR for each comorbid condition

e.g.  $SRR(\text{diabetes}) = \frac{\# \text{ hospitalisations with diabetes discharged alive}}{\# \text{ hospitalisations with diabetes}}$

**ICD-10-AM** – one SRR for each ICD code within the comorbid conditions

e.g.  $SRR(E10.4) = \frac{\# \text{ hospitalisations with E10.4 discharged alive}}{\# \text{ hospitalisations with E10.4}}$



# Data

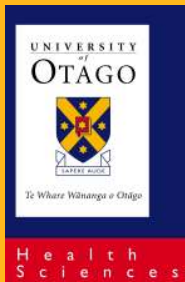
- Hospitalisations with S00-T89 PD discharged dead at any admission within 90 days of injury date where injury date was 1/1/2000-31/8/2003 excluding those readmissions where the 1st admission didn't have S00-T89 PD

plus

- 1st admission hospitalisations with an S00-T89 PD & injury date between 1/1/2000 & 31/8/2003 that either stayed at least one night in hospital or died within 90 days

plus

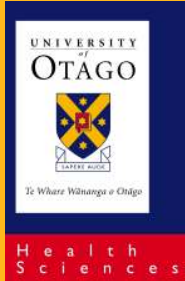
- Fatalities located in the Mortality Collection with date of death between 1/1/2000 & 31/8/2003 who had an S00-T89 diagnosis in any field
- **186,835 cases of which 9,968 (5.3%) were deaths (Excluding data from Mortality collection, there were 182,673 cases of which 1,969 (1.1%) were deaths)**



# Method - 1

- Calculated the following ICISs:

ICISS	Mortality Collection	Comorbidity	
		Approach	Level
ICISS1 (traditional)*	No	-	-
ICISS2	No	HARM	ICD-10-AM code
ICISS3	No	HARM	Variable
ICISS4	No	Charlson	ICD-10-AM code
ICISS5	No	Charlson	Variable
ICISS6	Yes	-	-
ICISS7	Yes	HARM	ICD-10-AM code
ICISS8	Yes	HARM	Variable
ICISS9	Yes	Charlson	ICD-10-AM code
ICISS10	Yes	Charlson	Variable



## Method - 2

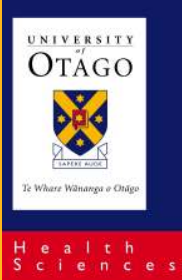
- Because average # of diagnoses per person in Hospitalisations data was 3x that from Mortality Collection, used 'worst injury' methodology

**ICISS = smallest[ SRR(A), SRR(B), ... , SRR(N) ]**

- For the ICISS scores that included comorbidity, comorbid SRRs (cSRRs) contributed as follows:

**ICISS = smallest[ SRR(A), SRR(B), ... , SRR(N) ]  
\* smallest[ cSRR(1), cSRR(2), ... , cSRR(M) ]**

where A, B, ...N = injury diagnoses and 1, 2, ...M = comorbid variable/ICD code

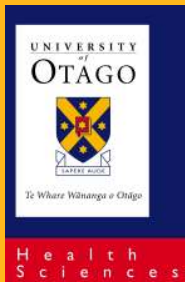


## *Method - 3*

- Compared the **discrimination** and **calibration** of ICISS2-ICISS10 with ICISS1

**Discrimination** – assessed by concordance; ability of ICISS to predict survivors from non-survivors on scale from 0-1

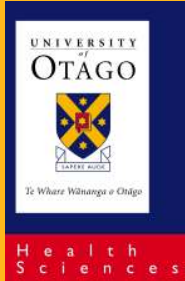
**Calibration** – assessed by Calibration curves & H-L statistic; indicates accuracy of estimates of probability of death



# Results table

ICISS	Concordance	95% CI*	H-L	R2
ICISS1	0.777	(0.772 , 0.783)	2757	0.123
ICISS2	0.800	(0.795 , 0.806)	1352	0.163
ICISS3	0.794	(0.790 , 0.798)	1361	0.150
ICISS4	0.818	(0.813 , 0.823)	1673	0.184
ICISS5	0.816	(0.811 , 0.821)	1710	0.175
ICISS6	0.851	(0.848 , 0.855)	2222	0.227
ICISS7	0.874	(0.870 , 0.877)	1233	0.282
ICISS8	0.866	(0.863 , 0.870)	1256	0.262
ICISS9	<b>0.891</b>	<b>(0.888 , 0.894)</b>	926	<b>0.328</b>
ICISS10	0.885	(0.882 , 0.888)	<b>910</b>	0.301

\*Bootstrap adjusted CI

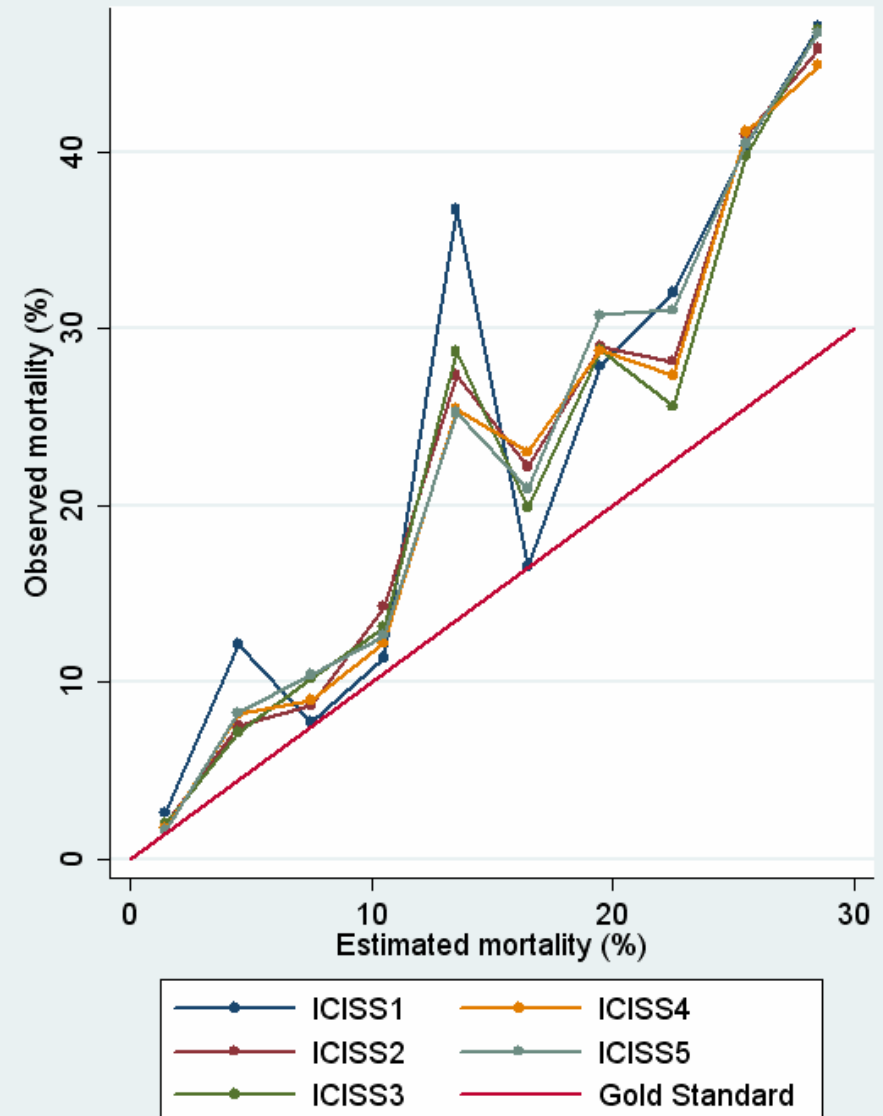


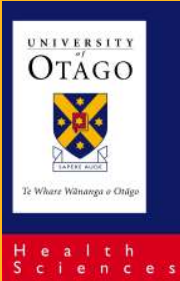
# Results – Concordance

- **Best = ICISS9** (mortality data and CCI at ICD-10-AM level)  
**Worst = ICISS1** (traditional)
- ICISS6-10 (hospitalisation and mortality data) all had better concordance than ICISS1-5 (hospitalisation data only)
- Scores using comorbidity data had higher concordance than corresponding score that didn't include comorbidity
- Scores using CCI had better concordance than those using HARM
- Scores using comorbidity SRRs at ICD-10-AM level had higher concordance than respective scores using SRRs at variable level

# Results – Calibration 1

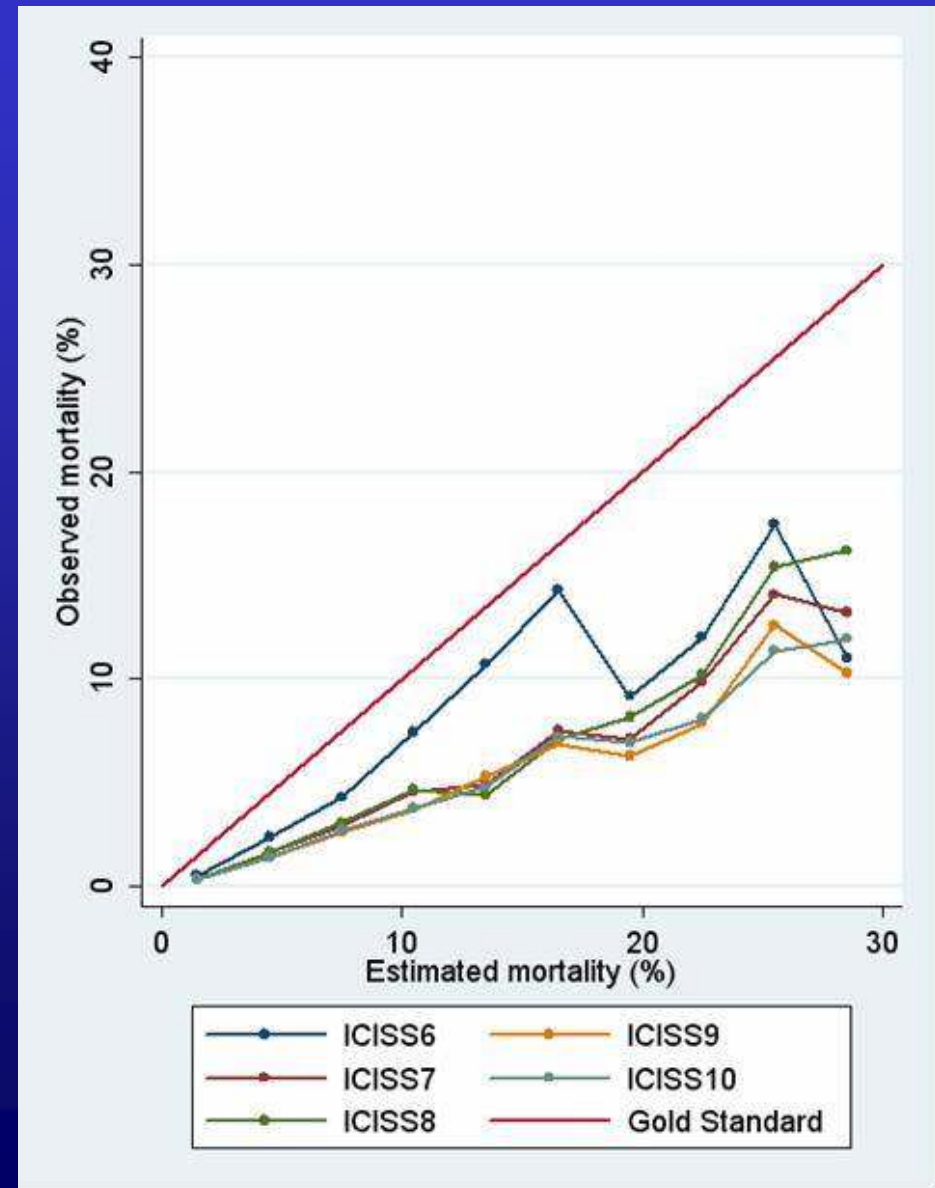
- Since the vast majority of cases have ICISS close to 1, only cases with estimated mortality  $\leq 30\%$  are presented. (Corresponds to 90-99% of the data depending on which ICISS)
- Differences in performance is difficult to assess through calibration curves
- Calibration was generally better at lower levels of estimated mortality

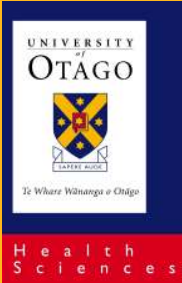




## Results – Calibration 2

- Scores that used hospital data only to calculate SRRs (ICISS1-5) underestimated mortality whereas those that used hospital + mortality data (ICISS6-10) overestimated mortality
- H-L statistic was better for scores that included comorbidity
- Scores that included mortality data & CCI (ICISS9&10) had the best H-L statistics

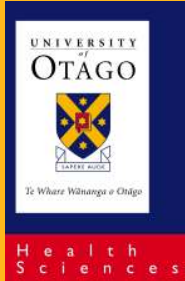




## *In summary*

Can we improve the predictive ability of ICISS by....

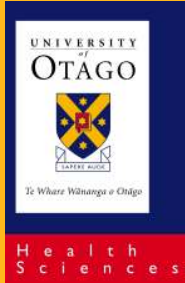
- **Using both NZHIS Hospitalisations & Mortality data in ICISS calculation - YES**
- **Accounting for comorbidity – YES**



## *Issues – mortality data*

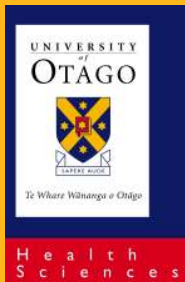
- Recording & coding of deaths that occur outside hospital is very different to that for in-hospital deaths
- Injury diagnostic codes used in the Mortality Collection appear to be less specific than those in the NMDS – may explain the overestimation of mortality by models include deaths from the Mortality Collection (ICISS6-10).

→ **IPRU is currently negotiating funding to explore the reliability of the diagnoses in the Mortality Collection**



# Issues – Comorbidity

- Data availability?
- Only the worst comorbid SRR was included. In comparison, the HARM approach had separate terms in model for each comorbid condition
- Age is correlated with comorbidity
  - Is including comorbidity usefully better than the simpler term, age?
  - Is there justification for including both?
- Since vast majority of comorbidity occurs in older people:
  - Should SRRs be population group dependent? E.g. SRRs be calculated separately for 0-74 yr olds & 75+ yr olds
  - Should there be separate serious non-fatal indicators for children/adults and for older people for all priority areas?



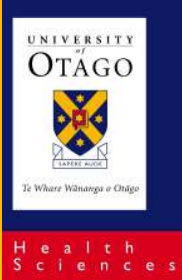
# *Policy implications*

**Suggests the methodology used to obtain severity scores from which injuries are classified could be improved**

→ **Impact on current NZIPS serious non-fatal injury indicators?**

- Using  $ICISS1 \leq 0.941$  essentially selects a "basket" of diagnoses that have high probability of admission (face validity)
- Diagnoses captured are essentially the operational definition of serious non-fatal injury used for the NZIPS
- Using e.g.  $ICISS9$ , would require a different threshold to be chosen  
Hypothesis =  $ICISS9$  threshold chosen that results in an operational definition of "serious injury" based on a similar list of diagnoses

→ **Unlikely current NZIPS indicators are misleading**



## Conclusions

- Evidence to suggest the predictive ability of ICISS can be improved by using Mortality data and accounting for comorbidity
- Current NZIPS serious non-fatal injury indicators calculated without either **BUT** expect this work doesn't compromise their validity

→ Rather than modify the methodology used to define 'serious non-fatal injuries' on an ad-hoc basis, it was agreed by the Interagency Injury Indicators Group to update every 5 yrs (2010).