Using Injury Severity to Improve Occupational Traumatic Injury Trend Estimates

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Work-Related Injury Trends

• Decreasing trends in work-related injury rates
  – WA Dept of Labor and Industries (L&I): 17% ↓ in compensable WC claims (2003 to 2008)

• Increasing barriers to complete surveillance
  – Under-reporting (Azaroff, 2002)
  – Constricting WC coverage/changing workforce (Azaroff, 2004)
  – Changes in SOII reporting requirements (Friedman & Forst, 2007)
Health-Care Based Surveillance

- More complete surveillance?
  - May contain a work-related field other than payer
  - Expected payer rather than filed/accepted WC claims

- Hospital discharge data (relying on payer=WC) have shown downward trends (CSTE OHI #2; Dembe et al, 2003)

- Some studies have not found evidence of ↓ trends (these didn’t rely on payer=WC)
  - IL Trauma Registry: 1995-2003 (Friedman & Forst, 2007)
  - WA Trauma Registry 2003-2008 (Sears et al, 2011)
Washington State Trauma Registry

• Minor trauma excluded (ISS < 9)
  – Focus on severe injuries that WTR was designed to capture
  – Limit variation in reporting practices for minor injuries
  – Limit inclusion of injuries solely based on transport/transfer (due to geography/resources rather than severity)

• Mean annual ↑ of 5.3% in age-adjusted rates of severe work-related trauma, 2003-2008 (95% CI: 3.3%, 7.4%)

• Flat trend when all work-related trauma reports were included (0.9%; 95% CI: -0.7%, 2.4%)
Severity Restriction

According to the National Center for Health Statistics (NCHS) Expert Group on Injury Severity Measurement:

“Trends in injury hospitalization discharges and ED visits represent a mixture of at least two effects:

1) Trends in the incidence of injury
2) Trends in service utilization and service delivery

Because both can vary over time...the incidence of injury would be better reflected by an indicator of the injury (eg, *injuries meeting a severity threshold*) that is ‘free’ of extraneous factors like utilization and service delivery”

Two other “extraneous factors” that may be decreasing over time:

1) WC coverage/covered workforce
2) Reporting of minor injuries
Severity Restriction

- Has been discussed in the general injury literature (Cryer, 2002 & 2008)

- Decreasing trends for minor (but not severe) TBI were more likely related to changes in probability of hospital admission than to population incidence (Thurman & Guerrero, 1999; Colantonio et al, 2009; Stephenson et al, 2005)

- Almost no discussion in occupational injury literature

- Increasingly incomplete capture of minor injuries along with inadequate severity measurement may be affecting estimates of work-related injury trends
WA State Work-Related Traumatic Injury Rates

Year injury occurred

Injury rate per 100,000 workers (CPS)

- Minor (WTR)
- Moderate (WTR)
- Major (WTR)
- Fatalities (FACE)
WA State Work-Related Traumatic Injury Rates

Injury rate per 100,000 workers (CPS)

Year injury occurred

- Minor (WTR)
- Moderate (WTR)
- Major (WTR)
- Fatalities (FACE)

Hypothetical unobserved minor injuries
Research Aim

Assess whether the use of severity restriction to identify the subset of severe work-related traumatic injuries results in different trend estimates than does including all hospitalized work-related traumatic injuries.
Data Sources: NHDS

• NHDS: National Hospital Discharge Survey
  – National probability sample of hospital discharges
  – Freely available public use data (CDC)

• Up to 7 ICD-9-CM diagnosis fields

• Expected payer includes distinct WC category
Data Sources: SID & CHARS

- **SID**: State Inpatient Databases (HCUP: Healthcare Cost & Utilization Project)
  - Arizona (AZ)
  - Florida (FL)
  - New Jersey (NJ)
- **CHARS**: Comprehensive Hospital Abstract Reporting System
  - Washington State (WA)
- **Contain nearly all community hospital discharges**
Eligibility

• Inclusion criteria:
  – Hospital discharges from 1998 through 2009
  – Primary expected payer=WC
  – Traumatic injury based on first-listed diagnosis

• Exclusion criteria:
  – Under age 16
  – Residing outside hospital discharge state
Traumatic Injuries

• Defined per National Trauma Data Bank (NTDB)
  – ICD-9-CM code in range 800–959.9, excluding:
    • 905–909.9 (late effects of injury)
    • 910–924.9 (superficial injuries)
    • 930–939.9 (foreign bodies)
    • 940-949.9 (burns; -icdpc- doesn’t score burns)

• First-listed ICD-9-CM diagnosis code only
  – Number of ICD-9-CM codes changes over time
  – Incidental superficial injuries don’t result in inclusion
  – Safe States Alliance consensus recommendations
Injury Severity: AIS

• AIS: Abbreviated Injury Scale
  – Association for the Advancement of Automotive Medicine
  – Ranks injury severity based on threat to life
  – Anatomically-based consensus-driven approach
  – Independent of patient-specific factors such as comorbidity that may influence hospitalization
  – Ordinal severity scale: 1 to 6 (3=serious)

• Severe injury defined as AIS>2 for this study
Injury Severity Estimation

• AIS estimated from first-listed diagnosis using –icdpic-
  – Stata user-written software program (Clark, Osler, Hahn)
  – Developed using National Trauma Data Bank data
  – Contains a crosswalk from ICD-9-CM to AIS
  – In process of refining –icdpic- crosswalk

• Most serious injury predicts mortality as well as all injuries (Kilgo et al, 2003)

• We found little difference using Injury Severity Score (ISS) based on all ICD-9-CM codes

• Simplicity for state-based Occupational Health Indicator
Rates and Denominators

• Injury discharge rates for 1998-2009

• Employed population denominators based on Current Population Survey (CPS)

• Age adjustment using direct standardization to the U.S. 2000 Standard Population (ages 16+)

• NHDS: not age-adjusted because too few WC discharges in each age category
Trend Models

• Negative binomial regression with an offset for denominator at risk

• Models run with & without severity restriction

• Temporal trend divergence by severity was tested using an interaction term
## Trend Divergence Tests

<table>
<thead>
<tr>
<th>Data source</th>
<th>State Fund?</th>
<th>1998 employed pop (thousands)</th>
<th>1998 WC injury rate</th>
<th>Interaction (severe/minor)</th>
<th>P-value (severe vs minor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WA</td>
<td>Yes: exclusive</td>
<td>2,894</td>
<td>46.8</td>
<td>1.026</td>
<td>.004</td>
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<tr>
<td>NJ</td>
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<td>3,963</td>
<td>62.6</td>
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<td>1.003</td>
<td>NS</td>
</tr>
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<td>2,178</td>
<td>46.3</td>
<td>1.025</td>
<td>NS</td>
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<td>NHDS</td>
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<td>131,463</td>
<td>40.4</td>
<td>1.057</td>
<td>.004</td>
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</table>

Interaction=Ratio of severe injury trend/minor injury trend
Results

• In all 5 data sets, the trend for severe injuries had an upward slope relative to minor injuries (significant difference in 3 of 5)

• More practically relevant to compare observed trends for all injuries vs. trends for severe injuries
  – Graphs for an “eyeball test”
  – Can’t test dependent groups using the same model
  – Compared confidence intervals of trend estimates

• Differences between all-injury and severe-injury trends not always significant or large, but direction of effect always the same
Washington, Age-Adjusted Rates

Hospital discharges/100K

Year of hospital discharge

Trend
% Δ/year
↓1.1%

↑0.6% (flat)

All injuries
Severe injuries
New Jersey, Age-Adjusted Rates

- All injuries
- Severe injuries

Trend
- % Δ/year
  - ↓5.1%
  - ↓2.1%
Florida, Age-Adjusted Rates

Trend
% Δ/year
↓3.8%
↓3.6%

Hospital discharges/100K

Year of hospital discharge

All injuries
Severe injuries
Arizona, Age-Adjusted Rates

Year of hospital discharge

Hospital discharges/100K

Trend
% Δ/year
↓0.8% (flat)

↑1.0% (flat)
<table>
<thead>
<tr>
<th>Year of hospital discharge</th>
<th>Hospital discharges/100K</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>40</td>
</tr>
<tr>
<td>2000</td>
<td>35</td>
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<td>2002</td>
<td>30</td>
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<tr>
<td>2004</td>
<td>25</td>
</tr>
<tr>
<td>2006</td>
<td>20</td>
</tr>
<tr>
<td>2008</td>
<td>15</td>
</tr>
</tbody>
</table>

**Trend**

- % Δ/year
  - ↓3.7%
  - ↑0.4% (flat)

**National Hospital Discharge Survey, Crude Rates**

- **All injuries**
- **Severe injuries**
How might assessments of occupational injury trends differ if based on all injuries vs. only severe injuries?
Conclusions

• Severity restriction improves accuracy of trend measurement by reducing bias due to:
  – Increasingly restrictive hospital admission practices
  – Constricting WC coverage/workforce changes
  – Decreased reporting of minor injuries

• Inadequate severity characterization may lead to unwarranted optimism about injury trends

• We plan to run these models for more states and using NTDB data
Unanswered Questions

• Death would seem to be the ultimate severity restriction; but work-related fatalities also decreasing
  – ↑ severe injuries may not translate into ↑ fatalities if we are meeting goals set by targeted workplace fatality prevention programs and trauma care systems
  – Trauma center case survival rate has improved most dramatically for those with major trauma

• Similar effects in WC, SOII, other databases?

• How to implement a severity restriction if ICD-9-CM codes and AIS unavailable?
New CSTE OHI Proposal: Work-Related Severe Traumatic Injury Hospitalizations

• 20 state-based occupational health indicators
  – 2\textsuperscript{nd} indicator: Work-Related Hospitalizations
  – Annual number & rate of hospitalizations of state residents ≥16 years with WC as primary payer
  – Hospitalizations are heterogeneous (surgery, illness)
• Developing a list of ICD-9-CM diagnosis codes that correspond to severe injuries (AIS>2)
• Severe injuries may be more consistent bellwether of work-related injury trends than all hospitalizations
Thank you!

Questions?

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References


Clark DE, Osler TM, Hahn DR. ICDPIC: Stata module to provide methods for translating ICD (Ninth Revision) diagnosis codes into standard injury categories and/or scores. Available at: http://ideas.repec.org/c/boc/bocode/s457028.html.


Cryer C, Langley J. Developing indicators of injury incidence that can be used to monitor global, regional and local trends. 2008. Available at: http://www.otago.ac.nz/ipru/ReportsPDFs/OR070.pdf.


Extra Slides
### Comparing “All” to “Severe” Trends

<table>
<thead>
<tr>
<th>Data source</th>
<th>All Injury (95% CI)</th>
<th>Severe Injury (95% CI)</th>
<th>CI Overlap?</th>
<th>Significant?</th>
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</thead>
<tbody>
<tr>
<td>WA</td>
<td>↓1.1%</td>
<td>↑0.6% (flat)</td>
<td>Some</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>↓2.0% -↓0.2%</td>
<td>↓0.7% -↑1.9%</td>
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<td></td>
</tr>
<tr>
<td>NJ</td>
<td>↓5.1%</td>
<td>↓2.1%</td>
<td>None</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>↓6.3% -↓3.9%</td>
<td>↓3.5% -↓0.7%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FL</td>
<td>↓3.8%</td>
<td>↓3.6%</td>
<td>Substantial</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>↓4.9% -↓2.7%</td>
<td>↓4.8% -↓2.3%</td>
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<td></td>
</tr>
<tr>
<td>AZ</td>
<td>↓0.8% (flat)</td>
<td>↑1.0% (flat)</td>
<td>Substantial</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>↓3.4% -↑1.8%</td>
<td>↓2.1% -↑4.1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NHDS</td>
<td>↓3.7%</td>
<td>↑0.4% (flat)</td>
<td>Some</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>↓5.8% -↓1.6%</td>
<td>↓2.3% -↑3.0%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Work-Relatedness

• WC as primary expected payer

• CSTE: “WC as primary payer is a good proxy for the work-relatedness of hospitalized injuries”

• Underestimates work-related injuries
  – Sensitivity 89%; Specificity 98% (Sears et al, 2012)
  – Sensitivity=83%; Specificity=98% (Sorock et al, 1993)

• Our interest lies in assessing differences in trends by severity rather than in assessing absolute rates or trends
Trauma Registries

- Trauma registry advantages:
  - Contain clinical AIS severity information
  - Many contain a work-relatedness field, not tied to payer

- Not all states maintain a trauma registry (32 in 2007; Guice et al)

- Fewer have work-relatedness field (21 in 2007; Guice et al)

- State-by-state variation in inclusion/exclusion criteria and hospital participation/population coverage

- NTDB not yet population-based; now includes occupation and industry in addition to work-relatedness