Research Day Symposium

April 5, 2018
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I want my legacy to be _______.
Research Day Symposium
April 5, 2018
Keynote Address
Eldercare and Work among Informal Caregivers

Rebecca L. Clancy, B.S. & Gwen Fisher, Ph.D.
Colorado State University | Department of Psychology
Acknowledgements

• Gwen Fisher, CSU Psychology
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• Chris Henle, CSU Management
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• Jean McCarthy, Kemmy Business School, University of Limerick, Ireland

This research was supported by the Mountains and Plains Education and Research Center, Grant T42OH009229, funded by the Centers for Disease Control and Prevention.
Background

• The world population aged 60 or over is the fastest growing population, increasing at a rate of 3.26% per year.
  • By 2050, all major areas continents will have nearly a quarter or more of their populations aged 60 or over.
• Life expectancy in the U.S. is currently 78.6 years (81.1 years for women, and 76.1 years for men)
  • Life expectancy is projected to continue rising globally
Background

• Labor force participation rates of women aged 25-54 climbed from an average of 54% in 1980 to 71% in 2010

• 1 of every 6 employees is a caregiver for a disabled or elderly family member
  • 70% of caregivers report suffering difficulties at work due to their caregiving responsibilities, which often add up to 20 hours per week
Background

• There is currently no systematic review of what we know about eldercare and work across disciplines

**Purpose:** Synthesize and integrate existing literature to understand the process of combining eldercare and work
Work / Family Conflict

• Work–family conflict is a stressor that occurs when there are incompatible demands between the work and family roles of an individual that makes participation in both roles more difficult, leading to strain.
Defining Caregiving

Caregiving is a process that takes place over time as people age, and both care recipients’ and caregivers’ needs change over time.
Theoretical Framework

• Role Theory (Kahn et al., 1964)

• Social Role Theory (Eagly, 1987, 1997; Eagly, Wood & Diekman, 2000)

• Job Demands/Resources Model (Demerouti, Bakker, Nachreiner, & Schaufeli, 2001)

• Ecological Systems Theory (Bronfenbrenner, 1977)
Antecedents

Societal
- Family leave policies
- Norms and expectations

Work-related
- Employment status
- HR policies and practices

Family
- Caregiving relationship
- Care recipient characteristics
- Spouse/partner’s work status
- Spouse/partner’s support for retirement
- Family composition

Individual Caregiver
- Demographic characteristics
  - Gender
  - Age
  - Education & Socioeconomic Status

Consequences

Societal
- Labor supply

Work-related
- Discrimination
- Job performance
- Work-related strain
- Absenteeism / Presenteeism
- Turnover/retirement/labor market exit
- Changing jobs
- Job satisfaction

Family
- Care recipient health and wellbeing
- Marital quality
- Caregiving relationship quality

Moderators

Individual
- Gender
- Race/ethnicity
- Caregiver
- Caregiving demands

Work Context Variables
- Organizational policies and programs
- Flexible work arrangements

Societal
- Government programs

Mediators

Work Variables
- Work/family conflict
- Work/career disruptions
Antecedents

Societal
- Family leave policies
- Norms and expectations

Work-related
- Employment status
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Individual
- Gender
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- Caregiving demands

Work Context Variables
- Organizational policies and programs
- Flexible work arrangements

Societal
- Government programs

Work-related
- Psychological strain
- Depression
- Anxiety
- Guilt
- Burnout and fatigue
- Psychological well-being
- Physical health
- Financial strain
### Individual Caregiver Factors
- Gender
- Age
- Education
- Socioeconomic status

### Work-Related Factors
- Employment status
- HR policies

### Family Factors
- Caregiving relationship
- Care recipient characteristics
- Spouse/partner work status
- Family composition

### Societal Factors
- Family leave policies
- Norms and expectations
**Individual Caregiver Factors**
- Gender
- Age
- Education
- Socioeconomic status

**Family Factors**
- Caregiving relationship
- Care recipient characteristics
- **Spouse/partner work status**
- Family composition

**Work-Related Factors**
- Employment status
- **HR policies**

**Societal Factors**
- Family leave policies
- Norms and expectations
<table>
<thead>
<tr>
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<th>Family Factors</th>
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<tr>
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<td>Care recipient health and well-being</td>
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<tr>
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<td>Changing jobs</td>
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Individual Caregiver Factors

Psychological strain
Psychological well-being
Physical health
Financial strain

Family Factors

Care recipient health and well-being
Marital quality
Caregiving relationship quality

Work-Related Factors

Discrimination
Job performance
Work-related strain
Absenteeism/presenteeism
Turnover/retirement
Changing jobs
Job satisfaction

Societal Factors

Labor supply
Key Findings

• Certain types of people are more likely to provide eldercare than others
• There are both positive and negative outcomes that result from providing eldercare
• Policy, whether at the federal, organizational, or supervisor level, can play a major role in the eldercare process
Implications for Future Research

Need for…

- More longitudinal research
- Holistic model testing
- Diverse samples
- Improved measurement
Practical Implications for Occupational Health and Leaving a Legacy

• Creation of policies and programs to support workers with caregiving responsibilities
  • Provision for time off, and particularly paid family leave time, would go a long way toward supporting elder caregivers.
  • Support programs for employees with eldercare responsibilities
Questions?
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April 5, 2018
The Pseudo Pelger-Huet Anomaly as a Potential Biodosimeter for Chronic Low Dose Radiation Exposure of Mammalian Species within the Fukushima Daiichi Exclusion Zone

Joshua M. Hayes
M.S. Student Health Physics
Colorado State University
Background

• In March of 2011, a 9.0 magnitude earthquake led to a tsunami that struck the East Coast of Japan.
• The Fukushima Dai-ichi Nuclear power plant was severely damaged.
• Electricity and back up generators failed leading reactors to over pressurize and release a plume of radionuclides that spread to the Northwest.
• Zero deaths due to Acute Radiation Syndrome.
Radionuclides released
- Iodine 131 (half life 8.02 days)
- Cesium 134 (half life 2.06 years)
- Cesium 137 (half life 30.17 years)

- Cesium 137 main concern
  - Long half life
  - Potassium analog

← Radiation Dose Data from 2011
Opportunity for Research

• Humans evacuated; animals and nature were left to take over in the contaminated environment.

• Animals such as macaque monkeys, wild boar, and wild mice have become an excellent model for radioecology research.
Hypothesis

• An increased concentration of the Pseudo Pelger-Huet anomaly in peripheral blood can estimate radiation dose to a mammalian species subjected to chronic low dose exposure to radiation.
• Chronic low dose exposure results in increases in physiological stress that leads to quantifiable increases in cortisol levels in mammalian hair samples.
Project Overview

• Live Animal Capture/Sample Collection
  • Mice and Wild Boar
  • Organ harvest during field necropsy

• Dosimetry methods for estimation of lifetime dose

• Pseudo Pelger-Huet Anomaly quantification
  • Blood smears stained and evaluated in bright field

• Cortisol quantification
  • methanol/ether extraction and evaluation using Enzyme Linked Immunosorbent Assays (ELISA).
Collection Sites

- Wild Boar were collected from Fukushima Prefecture and the Savannah River Ecology Laboratory (SREL)

Control sites
- Soma, Fukushima City, Aizu, and SREL.

Contaminated Sites
- Namie and Okuma.
Animal Capture Methods in Japan

**Mice (Nezumi)**
- Mice were captured in trap lines set in varying habitats.
- Baited with peanuts and checked daily.

**Wild Boar (Inoshishi)**
- Government contracted hunters set traps throughout Namie.
- Baited and checked several times per week.
Animal Capture Methods at SREL

A different approach to trapping wild boar that took advantage of family groups
Dosimetry

**Mice (Nezumi)**
- Collared with OSL chips and released.
- Recaptured collars were read and dose was estimated.
- Air dosimetry was also taken at the trap lines.
- Whole body cesium analysis.

**Wild Boar (Inoshishi)**
- In the past boar were collared and released.
- Air dosimetry was taken at the sight of capture.
- Muscle cesium analysis.
- Electron spinning resonance to estimate lifetime dose.
Sample Sizes for PHA Study

**Mice (Nezumi)**
- Blood smears taken
- 10 from control areas
- 10 from contaminated areas

**Wild Boar (Inoshishi)**
- Total animals collected
- 24 from control sites
- 19 from contaminated sites
What is a Pseudo Pelger-Huet Cell?

- Pelger-Huet cells are naturally occurring in neutrophils due to a mutation on chromosome 1.
  - Causes defect in Laminin-B receptor
- ‘Pseudo’ refers to it being an induced anomaly.
  - Radiation or toxin
  - Anaphase bridge
  - Leads to hypo segmentation
Pseudo Pelger-Huet Cells in Criticality Accidents

• Dr. Ronald Goans found a dose response in victims of a criticality accident.

• What about low dose exposure though?

APPEARANCE OF PSEUDO-PELGER HUET ANOMALY AFTER ACCIDENTAL EXPOSURE TO IONIZING RADIATION IN VIVO

Ronald E. Goans,* Carol J. Iddins,† Doran Christensen,† Albert Wiley,† and Nicholas Dainiak‡
Environmental Exposure in South Africa

100 μSv/h: PH% = 22.66%
20 μSv/h: PH% = 12.67%
Control: 0.27% (humans ~4%)

Monazite: Mineral with high Thorium content.
Evaluated Via Blood Smears

• Single drop of blood smeared to create a monolayer of cells.
  • Stained using Giemsa stain.
• Viewed under 40x magnification.
• Inflammation in animals considered while quantifying cells.
  • Why?
Cortisol and Physiological Stress

• Cortisol levels in Boar Hair as a function of radiation exposure.
  • Indicative of physiological stress.
  • Why hair not blood cortisol?

• Methanol/Ether extraction to be verified
  next week using an ELISA assay

• Sample size
  • Contaminated approximately 60
  • Control population 35
Special Thanks

Samantha Pederson, DVM
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MOUNTAIN & PLAINS ERC
A NIOSH Education and Research Center for Occupational & Environmental Health & Safety

環境放射能研究所
Fukushima University
Questions?
Evaluation of Nano-sized Particle Generation from Mining Activity

Daniel Theisen, Jared Khattak, Candace S-J Tsai*, Sc.D, CIH
College of Veterinary Medicine and Biomedical Sciences,
Colorado State University
Collaborator: Jurgen Brune, PhD, Colorado School of Mines
NIOSH Coal Workers X-ray Program 1970-2009

Percentage of miners with Coal Workers Pneumoconiosis

Percentage of miners with Progressive Massive Fibrosis

Hypothesis:

• The mining activity produces a high number of nanometer-sized particles which may represent an unacknowledged exposure present in the mining environment.

• Traditional gravimetric based methods for exposure assessment may not effectively characterize the respiratory insult experienced by miners.
Sampling Strategy

- Stationary Activity
  - Drilling into mine wall generates an aerosol that may be poorly characterized
- Mobile Activity
  - Settled dust generated during mining activities may present potential route of exposure when disturbed
- Control
  - Upwind sampling
Test Site:

- Edgar Mine, Colorado School of Mines Experimental Mine

Main shaft air flow
215 ft./min Air Velocity

Side View

Sampling Location for Source
7 ft.

Drilling Location

Back/Ceiling

Excavation still/floor

5 ft.
Instruments

• Real Time Instruments
  • Scanning Mobility Particle Sizer (SMPS, TSI 3910, 10-420 nm)
  • Optical Particle Sizer (OPS, TSI 3330, 300 nm - 10 µm)

• Analysis
  • Transmission Electron Microscope (TEM, JOEL JEM-2100F)
  • Scanning Electron Microscope (SEM, JOEL JSL-6500F)
  • Microbalance (Mettler Toledo MX5 Microbalance)

• Particle Samplers
  • 10 mm Respirable Cyclone (Gravimetric Sample)
  • Tsai Diffusion Sampler (TDS, TEM Grid and Polycarbonate Filter Sample)
Stationary Activity-Drilling
Particle Sampler Findings

- Real Time Instrument Data
  - Total Concentration
  - Size Distribution

- Particle Samplers
  - TDS
  - Respirable Cyclone
Real Time Data of Drilling

Total Number Concentration

• **OPS**: Measurement range: 0.3 µm – 10 µm
• **SMPS**: Measurement range: 10 nm – 420 nm
Particle Concentration for Sampling Period

Average Concentration per Sample

- **OPS**
- **SMPS**

<table>
<thead>
<tr>
<th></th>
<th>OPS</th>
<th>SMPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background</td>
<td>0.0E+00</td>
<td>0.0E+00</td>
</tr>
<tr>
<td>Sample 1</td>
<td>5.0E+02</td>
<td>1.0E+03</td>
</tr>
<tr>
<td>Sample 2</td>
<td>1.0E+03</td>
<td>1.5E+03</td>
</tr>
<tr>
<td>Sample 3</td>
<td>2.0E+03</td>
<td>2.5E+03</td>
</tr>
<tr>
<td>Average</td>
<td>1.0E+06</td>
<td>1.5E+06</td>
</tr>
</tbody>
</table>

Center for Health, Work & Environment
Colorado School of Public Health

Environmental & Occupational Health
Colorado School of Public Health
Particle Size Distribution at Stationary Activity

- **OPS**: Measurement range: 0.3 µm – 10 µm
- **SMPS**: Measurement range: 10 nm – 420 nm
TDS Findings

- Sample 1
  - 1 Hole, 10 min

Scale bar for SEM images is 1 \( \mu \text{m} \)
TDS Findings: Sample 1

- EDS analysis
  - Primarily silicon rich particles, oxides and soot.
TDS Findings: Sample 2

- EDS analysis
- Consistent with sample 1: silica, metal oxides, and soot.
TDS Findings: Sample 2 Continued

Spherical Iron Oxides  Carbon Rich (Soot)
TDS Findings Sample 4

Scale bar = 100 nm

Scale bar = 1 μm
Respirable Cyclone Sample 4

• The gravimetric weight for the stationary site respirable cyclone sample was below the limit of detection (LOD) for the scale.

• A long-term sampling will be taken next visit.
Mobile Activity Findings – Golf cart drive

• 10 minutes of continuous laps throughout the mine excavations

• No Real Time Concentration Measurement

• Samplers
  • TDS
  • Respirable Cyclone
Mobile Activity Findings

- TDS
  - Low particle density
  - 500 nm +
  - Silica rich
- Respirable Cyclone
  - Below LOD
Air Intake Control Sample

- TDS
  - Very Few particles collected
- Respirable Cyclone
  - Below LOD
Summary

• Evidence exists that drilling generates a high number of particles in the sub micron size range.

• The aerosol has a complex elemental composition.

• This survey will help us develop a more comprehensive evaluation with task based and full shift measurements in the future.
Acknowledgments

This research was funded by the Alpha Foundation Technology Development and Exploratory Research Fund, Principle Investigator – Dr. Candace Tsai, and supported by the Grant T42OH009229, funded by the Centers for Disease Control and Prevention.
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Round-Table Discussions
Research Day Symposium
April 5, 2018
Atrial Fibrillation and Oil & Gas Development

Eero Dinkeloo, MPH candidate
Lisa McKenzie, PhD
Ben Allshouse, PhD

This work was supported by an award from the American Heart Association (AHA). The Center for Improving Value in Health Care (CIVHC) provided the All Payer Claims data. Any opinion, findings, and conclusions or recommendations expressed are those of the authors and do not necessarily reflect the views of the AHA or CIVHC.
Introduction

- Atrial Fibrillation – rapid, irregular heartbeat leading to improper blood flow
  - Symptoms include: palpitations, SOB, dizziness, and the potential for serious complications such as stroke
- Most common cardiac rhythm disorder
  - Contributes to an estimated 130,000 deaths and $6 billion in healthcare costs annually
- Risk factors include age, stress, hypertension, obesity, sleep apnea, etc.
Introduction

• An estimated 17.6 million Americans live within one mile of an active well
• In Colorado 10,000 wells have been drilled since 2012
• A number of pollutants are emitted from these sites
  • Particulate matter and noise are of notable concern for this population
• In 2015, 37% of complaints to the COGCC were related to noise
Introduction

**Table 2:** Mean truck counts and PM$_{2.5}$ at Colorado homes located 305 meters from a 22-well hydraulically fractured oil and gas site

<table>
<thead>
<tr>
<th>Activity</th>
<th>Truck counts per hour</th>
<th>PM$_{2.5}$ ng/m$^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling</td>
<td>1</td>
<td>3.8</td>
</tr>
<tr>
<td>Hydraulic Fracturing</td>
<td>9</td>
<td>8.2</td>
</tr>
</tbody>
</table>

PM$_{2.5}$: Particulate Matter 2.5 micrometer diameter, ng/m$^3$, nanograms per cubic meter

**Table 3:** One-minute continuous noise measurements at Colorado homes located 305 meters from a 22-well hydraulically fractured oil and gas site during drilling activities

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Percent of Measurements exceeding 50 dBA</th>
<th>Percent of measurements exceeding 60 dBC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daytime (7am – 7pm)</td>
<td>41%</td>
<td>97.5%</td>
</tr>
<tr>
<td>Nighttime (7pm – 7am)</td>
<td>24%</td>
<td>98.3%</td>
</tr>
</tbody>
</table>
Methods

- **Colorado All Payers Claims Database (COAPD):** Insurance claims database managed by the Center for Improving Value in Health care.
  - Dates back to 2009, covering about 65% of insured Coloradans
  - Includes Medicaid, Medicare, Medicare Advantage and the 21 largest commercial health plans

- **Colorado Oil and Gas Information System (COGIS):** maintained by Colorado Oil and Gas Conservation Committee
  - Includes data on well permits, location, development, and production
Table 1: Characteristics of All Payer Claims Database patients with a diagnosis of A-fib between 2009 and 2016 and living within one mile of a hydraulically fractured well site that was developed between 2010 and 2015.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Population, n</td>
<td>3,310</td>
</tr>
<tr>
<td>Gender, %</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>54.2</td>
</tr>
<tr>
<td>Female</td>
<td>45.8</td>
</tr>
<tr>
<td>Age in years, Mean (± SD)</td>
<td>72.4 (± 12.9)</td>
</tr>
<tr>
<td>Insurance Coverage, %</td>
<td></td>
</tr>
<tr>
<td>Commercial</td>
<td>45.4</td>
</tr>
<tr>
<td>Medicare</td>
<td>35.2</td>
</tr>
<tr>
<td>Medicaid</td>
<td>19.0</td>
</tr>
<tr>
<td>Unknown</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>Distance from Well in miles, Mean (± SD)</td>
<td>0.6 (± 0.2)</td>
</tr>
</tbody>
</table>
Number of health care encounters in surrounding population with Afib

Interrupted Time-Series

- Before HFOG well site
- Development of HFOG well site
- HFOG well site development completed

Time (months)
Preliminary Results

Distribution of Well Site Development Length

- Development Time (in Days)
- Percent

[Bar chart showing distribution of well site development length]
Preliminary Results

- Statistically significant differences exist between the number of claims filed before, during, and after well development (p < .0001)
  - 21.7% more claims filed during development period
  - 26.6% more claims filed during post-development period
- Differences also exist for only claims related to Afib (p < .0001)
  - These include: Afib, Angina, Cerebrovascular disease, Arterial Embolism & Thrombosis, and Heart Failure
  - 31.0% more claims filed during development period
  - 12.1% more claims filed during post-development period
Future Directions

• Construct a full model, adjusting for covariates
  • Including age, gender, distance from well, etc.
• Examine procedural/prescription component
• Explore more cardiovascular outcomes
Leaving a Legacy..
Research Day Symposium
April 5, 2018
A Descriptive Analysis of Workers Who Have Multiple Workers’ Compensation Claims

Courtland Keteyian, MD, MBA, MPH
Fellow, Occupational and Environmental Medicine
Colorado School of Public Health
University of Colorado
Introduction

• Greater than 1/3 of injured workers experience a subsequent new injury after returning to work.

• Repeat claims result in significantly higher costs and longer periods of work disability.

• Relatively little literature explores why workers experience repeat claims.
  – Worker Characteristics: younger age, male gender, lack of experience, and industry.
  – Types of Injuries: low back injuries, but with inconsistent findings.
Introduction

Purpose

Investigate characteristics of workers with multiple workers’ compensation claims

Hypothesis 1: Injury to a given location on the body increases the likelihood of future injury to any location on the body.

Hypothesis 2: Injury to a given location on the body increases the likelihood of future re-injury to the same location on the body.
Methods

**Data Characteristics**
- Age
- Gender
- Date of Injury
- SIC Code
- Body Part of Injury

**Study Period**
- Start: January 1, 2005
- End: July 31, 2015

**Inclusion**
- At least two claims
- No missing data related to age, gender, industry, body part
- Only first two claims used for analysis

114,569 Claims

77,494 Claims
Methods

Body Part Groups

- Low Back
- Proximal Upper Extremity: Elbow, Upper Arm, Shoulder, Clavicle and Scapula
- Distal Upper Extremity: Finger(s), Hand, Lower Arm, Thumb, Wrist
- Proximal Lower Extremity: Hip, Knee, Upper Leg

Andreas Vesalius, *De corporis humani fabrica libri septem*
Methods

Chi-Squared Univariate Associations

- Claims
  - First Claims / Any Body Part Second Claims
  - First Claims / Same Body Part Second Claims
- Characteristics
  - Gender
  - Age Group
  - Industry
  - Body Part Injured

Kaplan-Meier Survival Analysis

- Estimated five-year probability of second claim

Andreas Vesalius, *De corporis humani fabrica libri septime*
Results: Characteristics of Dataset

• Total Claims: 77,494
  - Single Claims: 74.9% (n=58,007)
  - *Any Body Part* Second Claims: 25.2% (n=19,487)
  - *Same Body Part* Second Claims: 5.4% (n=4,179)

• Chi Square: significant association between claims activity and characteristics (p < 0.05)
  - *Any Body Part* Second Claims: age, industry, and body part
  - *Same Body Part* Second Claims: gender, age, industry, and body part
Results: Probability of Second Claims by Industry
Results: Likelihood of Second Claim in 5 Years

Low Back

- Highest: Police (51.8%; 17.0%), Fire (35.1%; 13.2%)
- Lowest: Mining/Construction (21.4%; 6.0%), Retail (17.5%; 4.9%)
Results: Likelihood of Second Claim in 5 Years

Low Back
- Highest: Police (51.8%; 17.0%), Fire (35.1%; 13.2%)
- Lowest: Mining/Construction (21.4%; 6.0%), Retail (17.5%; 4.9%)

Proximal Upper Extremity
- Highest: Police (55.8%; 14.7%), Public Admin (39.9%; 6.7%)
- Lowest: Finance (20.3%; 4.5%), Retail (19.2%; 3.5%)
Results: Likelihood of Second Claim in 5 Years

- **Low Back**
  - Highest: Police (51.8%; 17.0%), Fire (35.1%; 13.2%)
  - Lowest: Mining/Construction (21.4%; 6.0%), Retail (17.5%; 4.9%)

- **Proximal Upper Extremity**
  - Highest: Police (55.8%; 14.7%), Public Admin (39.9%; 6.7%)
  - Lowest: Finance (20.3%; 4.5%), Retail (19.2%; 3.5%)

- **Distal Upper Extremity**
  - Highest: Agriculture/Forestry (44.5%; 27.2%), Police (41.0%; 15.6%)
  - Lowest: Mining/Construction (22.9%; 7.6%), Retail (15.5%; 6.4%)

In Agriculture/Forestry/Fishing, Distal Upper Extremity injuries represented 49.9% (n = 280) of second claims, and 84.7% (n = 171) of same body part second claims.
## Results: Likelihood of Second Claim in 5 Years

<table>
<thead>
<tr>
<th>Area</th>
<th>Highest</th>
<th>Lowest</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Back</strong></td>
<td>Highest: Police (51.8%; 17.0%), Fire (35.1%; 13.2%)&lt;br&gt;Lowest: Mining/Construction (21.4%; 6.0%), Retail (17.5%; 4.9%)</td>
<td></td>
</tr>
<tr>
<td><strong>Proximal Upper Extremity</strong></td>
<td>Highest: Police (55.8%; 14.7%), Public Admin (39.9%; 6.7%)&lt;br&gt;Lowest: Finance (20.3%; 4.5%), Retail (19.2%; 3.5%)</td>
<td></td>
</tr>
<tr>
<td><strong>Distal Upper Extremity</strong></td>
<td>Highest: Agriculture/Forestry (44.5%; 27.2%), Police (41.0%; 15.6%)&lt;br&gt;Lowest: Mining/Construction (22.9%; 7.6%), Retail (15.5%; 6.4%)</td>
<td></td>
</tr>
<tr>
<td><strong>Proximal Lower Extremity</strong></td>
<td>Highest: Police (55.0%; 14.9%), Fire (35.8%; 7.6%)&lt;br&gt;Lowest: Mining/Construction (24.7%; 4.19%), Retail (19.3%; 4.0%)</td>
<td></td>
</tr>
</tbody>
</table>
Limitations

• **Timing**: Claims prior to January 1, 2005 or after July 31, 2015.

• **Multiple Claims**: Excluded beyond the second claim.

• **Generalizability**: Only state of Colorado, only Pinnacol.

• **Healthy Worker Effect**: Inclusion occurred only if working.

• **Misclassification**: Possible in the original dataset.
Conclusions

First study to focus on relationship between body part and repeat claims.

1. Body part of first injury plays a role in subsequent injury.

2. Relationship between body part and claims varies depending upon the industry, with surprisingly high probabilities of second claims in certain industries.

3. Opportunity for clinicians to provide better counseling and for employers to target safety programs.
Future Directions

• Investigate characteristics of multiple claims beyond first two.
• Investigate characteristics of high-risk industries.
• Investigate characteristics of high-risk body parts.
Acknowledgments

Co-authors

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Lee Newman, MD, MA - Center for Health, Work & Environment

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@CHWENews
Unsafe Work Environments and Turnover:
A Study of Montana’s Oil and Gas Industry

Christopher Bradley, MT Dept of Labor and Industry
Julia Brennan, MT Dept of Labor and Industry
Barbara Wagner, MT Dept. Labor and Industry
Motivation

• Montana:
  • One of the highest rates of work-related injury and illness (BLS SOII)
  • Oil and gas is an expanding sector – particularly in eastern MT
    • In 10 years (‘05-'15) state employment grew 38%, eastern MT region grew 129% (MT DLI – QCEW)

• Safety is largely influenced by management (Barling et al, 2005)

• Firm-level studies showed:
  • Some industries, safety improved turnover, (Sherman et al, 2008; Lahiri et al, 2012) others did not (Swartz et al, 2017).

• We explore Oil and Gas Industry for all of Montana
  • Matching Workers’ Compensation (WC) and Unemployment Insurance (UI) Administrative Records
Research Questions

• Is improved safety associated with less turnover?

• Do workers respond to the injuries of coworkers by leaving their employment?
Dataset

• All MT Oil and Gas Industry Employers from 2010-2015
  • Unique time period for observing worker employment decisions
  • Unbalanced panel, quarterly observations, n=4,766
  • 296 Unique Employers, between 4 and 24 observations per employers
  • Observations with injuries = 788

• Employer Data
  • Quarterly UI Administrative Records

• Injury Data
  • Quarterly WC Administrative Records

• Other data: Crude oil and natural gas prices, unemployment rate
### Table 1: Summary Statistics of Model Variables

<table>
<thead>
<tr>
<th>Statistic</th>
<th>N</th>
<th>Mean</th>
<th>St. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turnover Rate</td>
<td>4,766</td>
<td>0.61</td>
<td>1.02</td>
<td>0.00</td>
<td>20.50</td>
</tr>
<tr>
<td>Separation Rate</td>
<td>4,766</td>
<td>0.31</td>
<td>0.59</td>
<td>0.00</td>
<td>11.00</td>
</tr>
<tr>
<td>Injury Rate</td>
<td>4,766</td>
<td>0.01</td>
<td>0.05</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Severe Injury Rate</td>
<td>4,766</td>
<td>0.004</td>
<td>0.02</td>
<td>0.00</td>
<td>0.50</td>
</tr>
<tr>
<td>Average Wages</td>
<td>4,766</td>
<td>$18,143</td>
<td>$14,033</td>
<td>$187</td>
<td>$374,538</td>
</tr>
<tr>
<td># Employees</td>
<td>4,766</td>
<td>25.68</td>
<td>46.21</td>
<td>1</td>
<td>536</td>
</tr>
<tr>
<td>Unemployment Rate</td>
<td>4,766</td>
<td>5.69</td>
<td>1.30</td>
<td>3.63</td>
<td>8.40</td>
</tr>
<tr>
<td>Nat. Gas Price</td>
<td>4,766</td>
<td>$3.79</td>
<td>$0.72</td>
<td>$2.47</td>
<td>$5.11</td>
</tr>
<tr>
<td>Crude Oil Price</td>
<td>4,766</td>
<td>$85.64</td>
<td>$17.52</td>
<td>$44.93</td>
<td>$104.11</td>
</tr>
</tbody>
</table>
Model

• Turnover:
  • Total Turnover Rate = (Hires+Separations)/Average # of Employees
  • Separation Rate = Separations/Average # of Employees

• Workers Comp injury rate proxies for safety climate
  • Total Injury Rate= # Workers’ Comp Claims/Average # of Employees
  • Severe Injury Rate = # Lost-work-time injuries/Average # of Employees

\[
\text{Turnover Rate} = \beta_1 \text{InjuryRate} + \beta_2 \text{AvgWage} + \beta_3 \text{AvgEmployment} + \beta_4 \text{UnemploymentRate} \\
+ \beta_5 \text{GasPrice} + \beta_6 \text{CrudePrice} + \beta_7 \text{Quarter2} + \beta_8 \text{Quarter3} + \beta_9 \text{Quarter4}
\]

• Employer Fixed Effects Estimator – Time demeaned data
• Robust standard error estimation
### Turnover-Total Injuries Model

<table>
<thead>
<tr>
<th>Dependent variable: Turnover Rate (log)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Std. Error:</td>
</tr>
<tr>
<td>Default</td>
</tr>
<tr>
<td>Driscoll-Kraay</td>
</tr>
<tr>
<td>Arellano</td>
</tr>
<tr>
<td><strong>Injury Rate (log)</strong></td>
</tr>
<tr>
<td>0.245**</td>
</tr>
<tr>
<td>(0.096)</td>
</tr>
<tr>
<td>0.245***</td>
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<tr>
<td>(0.088)</td>
</tr>
<tr>
<td>0.245*</td>
</tr>
<tr>
<td>(0.144)</td>
</tr>
<tr>
<td><strong>Average Wages (log)</strong></td>
</tr>
<tr>
<td>0.036***</td>
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<tr>
<td>(0.011)</td>
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<tr>
<td>0.036</td>
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<tr>
<td>(0.023)</td>
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<tr>
<td>0.036</td>
</tr>
<tr>
<td>(0.023)</td>
</tr>
<tr>
<td><strong>Avg Employment (log)</strong></td>
</tr>
<tr>
<td>-1.874***</td>
</tr>
<tr>
<td>(0.593)</td>
</tr>
<tr>
<td>-1.874***</td>
</tr>
<tr>
<td>(0.666)</td>
</tr>
<tr>
<td>-1.874</td>
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<tr>
<td>(1.313)</td>
</tr>
<tr>
<td><strong>Avg Employment Sq (log)</strong></td>
</tr>
<tr>
<td>-0.879*</td>
</tr>
<tr>
<td>(0.449)</td>
</tr>
<tr>
<td>-0.879</td>
</tr>
<tr>
<td>(0.744)</td>
</tr>
<tr>
<td>-0.879</td>
</tr>
<tr>
<td>(0.861)</td>
</tr>
<tr>
<td><strong>Unemployment Rate (log)</strong></td>
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<tr>
<td>0.019</td>
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<tr>
<td>(0.025)</td>
</tr>
<tr>
<td>0.019</td>
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<tr>
<td>(0.028)</td>
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<tr>
<td>0.019</td>
</tr>
<tr>
<td>(0.037)</td>
</tr>
<tr>
<td><strong>Gas Price (log)</strong></td>
</tr>
<tr>
<td>0.020</td>
</tr>
<tr>
<td>(0.023)</td>
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<tr>
<td>0.020</td>
</tr>
<tr>
<td>(0.021)</td>
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<tr>
<td>0.020</td>
</tr>
<tr>
<td>(0.022)</td>
</tr>
<tr>
<td><strong>Oil Price (log)</strong></td>
</tr>
<tr>
<td>0.021</td>
</tr>
<tr>
<td>(0.020)</td>
</tr>
<tr>
<td>0.021</td>
</tr>
<tr>
<td>(0.014)</td>
</tr>
<tr>
<td>0.021</td>
</tr>
<tr>
<td>(0.022)</td>
</tr>
<tr>
<td><strong>2nd Quarter (ind)</strong></td>
</tr>
<tr>
<td>0.064***</td>
</tr>
<tr>
<td>(0.012)</td>
</tr>
<tr>
<td>0.064***</td>
</tr>
<tr>
<td>(0.006)</td>
</tr>
<tr>
<td>0.064***</td>
</tr>
<tr>
<td>(0.013)</td>
</tr>
<tr>
<td><strong>3rd Quarter (ind)</strong></td>
</tr>
<tr>
<td>0.045***</td>
</tr>
<tr>
<td>(0.013)</td>
</tr>
<tr>
<td>0.045***</td>
</tr>
<tr>
<td>(0.013)</td>
</tr>
<tr>
<td>0.045***</td>
</tr>
<tr>
<td>(0.015)</td>
</tr>
<tr>
<td><strong>4th Quarter (ind)</strong></td>
</tr>
<tr>
<td>0.041***</td>
</tr>
<tr>
<td>(0.011)</td>
</tr>
<tr>
<td>0.041***</td>
</tr>
<tr>
<td>(0.008)</td>
</tr>
<tr>
<td>0.041***</td>
</tr>
<tr>
<td>(0.013)</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
</tr>
<tr>
<td>4,766</td>
</tr>
<tr>
<td>4,766</td>
</tr>
<tr>
<td>4,766</td>
</tr>
</tbody>
</table>

**Note:**

- **p** < 0.01
- **p** < 0.05
- **p** < 0.1

- 100% increase in injury rate -> 25% increase in turnover rate
- For the “average” employer, increase in injury rate from 1% to 2% yields an increase in nominal turnover of 4
### Table 3: Separation Rate with Robust Std. Errors

<table>
<thead>
<tr>
<th></th>
<th>Default</th>
<th>Driscoll-Kraay</th>
<th>Arellano</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injury Rate (log)</td>
<td>0.104</td>
<td>0.104</td>
<td>0.104</td>
</tr>
<tr>
<td></td>
<td>(0.078)</td>
<td>(0.078)</td>
<td>(0.119)</td>
</tr>
<tr>
<td>Average Wages (log)</td>
<td>0.052***</td>
<td>0.052***</td>
<td>0.052***</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.021)</td>
<td>(0.016)</td>
</tr>
<tr>
<td>Avg. Employment (log)</td>
<td>-0.026***</td>
<td>-0.026***</td>
<td>-0.026**</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.009)</td>
<td>(0.013)</td>
</tr>
<tr>
<td>Unemployment Rate (log)</td>
<td>-0.043**</td>
<td>-0.043**</td>
<td>-0.043*</td>
</tr>
<tr>
<td></td>
<td>(0.020)</td>
<td>(0.021)</td>
<td>(0.025)</td>
</tr>
<tr>
<td>Gas Price (log)</td>
<td>-0.001</td>
<td>-0.001</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>(0.019)</td>
<td>(0.014)</td>
<td>(0.017)</td>
</tr>
<tr>
<td>Oil Price (log)</td>
<td>-0.012</td>
<td>-0.012</td>
<td>-0.012</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.012)</td>
<td>(0.019)</td>
</tr>
<tr>
<td>2nd Quarter (ind)</td>
<td>0.025***</td>
<td>0.025***</td>
<td>0.025***</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.006)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>3rd Quarter (ind)</td>
<td>0.012</td>
<td>0.012</td>
<td>0.012</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.010)</td>
<td>(0.011)</td>
</tr>
<tr>
<td>4th Quarter (ind)</td>
<td>0.034***</td>
<td>0.034***</td>
<td>0.034***</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.008)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>Observations</td>
<td>4,766</td>
<td>4,766</td>
<td>4,766</td>
</tr>
</tbody>
</table>

Note:
* p** p*** p<0.01

---

**Separations-Total Injuries Model**

- Effect goes away
- Difference: removed hires from dependent variable
- Suggests total injuries is affected by # new employees
### Table 5: Separation Rate and Presence of Severe Injury with Robust Std. Errors

<table>
<thead>
<tr>
<th>Dependent variable: Separation Rate (log)</th>
<th>Std. Errors:</th>
<th>Default</th>
<th>Driscoll-Kraay</th>
<th>Arellano</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe Injury</td>
<td></td>
<td>0.033**</td>
<td>0.033***</td>
<td>0.033***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.013)</td>
<td>(0.010)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>Average Wages (log)</td>
<td></td>
<td>0.052***</td>
<td>0.052**</td>
<td>0.052***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.009)</td>
<td>(0.021)</td>
<td>(0.016)</td>
</tr>
<tr>
<td>Avg Employment (log)</td>
<td></td>
<td>-0.027***</td>
<td>-0.027***</td>
<td>-0.027**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.005)</td>
<td>(0.009)</td>
<td>(0.013)</td>
</tr>
<tr>
<td>Unemployment Rate (log)</td>
<td></td>
<td>-0.043**</td>
<td>-0.043**</td>
<td>-0.043*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.020)</td>
<td>(0.020)</td>
<td>(0.025)</td>
</tr>
<tr>
<td>Gas Price (log)</td>
<td></td>
<td>-0.0001</td>
<td>-0.0001</td>
<td>-0.0001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.019)</td>
<td>(0.014)</td>
<td>(0.017)</td>
</tr>
<tr>
<td>Oil Price (log)</td>
<td></td>
<td>-0.012</td>
<td>-0.012</td>
<td>-0.012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.016)</td>
<td>(0.012)</td>
<td>(0.019)</td>
</tr>
<tr>
<td>2nd Quarter (ind)</td>
<td></td>
<td>0.025***</td>
<td>0.025***</td>
<td>0.025***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.009)</td>
<td>(0.006)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>3rd Quarter (ind)</td>
<td></td>
<td>0.012</td>
<td>0.012</td>
<td>0.012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.010)</td>
<td>(0.010)</td>
<td>(0.011)</td>
</tr>
<tr>
<td>4th Quarter (ind)</td>
<td></td>
<td>0.034***</td>
<td>0.034***</td>
<td>0.034***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.009)</td>
<td>(0.008)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>Observations</td>
<td></td>
<td>4,766</td>
<td>4,766</td>
<td>4,766</td>
</tr>
</tbody>
</table>

**Note:** *p***p***p<0.01

### Separations-Severe Injuries Model

- **Quarters with a severe injury, increase in separation rate by 3.3 percentage points**

- **Not large enough to say whether non-injured workers affected by presence of severe injury**
Conclusions

• Severe injuries have a statistically significant, but small effect on employee separations in Montana’s oil and gas industry
• Total injury rate has no significant relationship with separation rate:
  • Wages compensate for injury risk?
  • Workers associate workplace risk with industry, not employer?
  • Reporting of non-severe injuries is inconsistent?
• It appears that hires link total turnover to total injury rates
  • Inexperienced workers get injured more? (Lagerstrom et al, 2017)
  • Future line of research
Next Steps

• Possible to distinguish separations from injured workers from others?
  • Use person-level instead of employer level injury data

• Continue using WC-UI data matching to research workplace safety issues
  • New project looking into value of apprenticeships for injury rates.
References

Questions?

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Economist, MT Department of Labor & Industry
cbradley@mt.gov
Thank You for Joining Us!

We’ll see you in April 2019