

# Perioperative Outcomes Among Surgeons Who Operated the Night Prior

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## Disclosures

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## Motivation

- Fatigue has been shown to adversely affect performance across a variety of domains (Neu et al., 2011; Goode 2003; Fullagar 2015)
- Concerns about fatigue and patient outcomes (Barger 2006; Gates 2018)
- While residents face duty hour restrictions, attendings do not
- Is this safe for patients?

## Summary of Findings

- Operating overnight was not associated with an increased risk of in-hospital death or major complication among the subsequent day's cases
- Small decrease (?) among subsequent day's cases
- Results generally robust across a variety of subgroup and sensitivity analyses

# Outline

- Background
- Sample
- Statistical Approach
- Results
- Conclusion

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# Background

- Previous work
  - Gates (2018): Systematic review of 47 studies, generally found no association between fatigue and poorer outcomes
  - Govindarajan (2015): Retrospective analysis of ~40k patients undergoing surgery at a Canadian province: no association between operating overnight and outcomes on the next day's cases
- Limitations of previous work
  - Underpowered to study mortality/complications
  - Subject to confounding (surgeons who work overnight are different from those who don't)
  - Self-reported overnight operating
  - Overly stringent definitions of operating overnight

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# Sample

- Inclusion criteria
  - Cases between January 1, 2010 and August 30, 2020
  - Nonmissing data on comorbidities, mortality, surgery CPT code, and whether the surgeon operated the previous night
  - Nonmissing data on case times
  - “Major therapeutic procedure” as defined by AHRQ

# Sample

- Initial Sample 2,110,956 cases
- Exclusion criteria
  - Surgeons who never operated overnight (n=1,332,069)
  - >1 attending surgeon (n=54,838)
  - Missing data: age (n=89), ASAPS (n=7,902)
  - ASA 5/6 (n=1,351)
  - Low risk/out of OR procedures
    - Upper endoscopy (n=47,127)
    - Lower endoscopy (n=22,262)
    - Ophthalmologic surgeries (n=41,851)
    - CVC access (n=16,435)
  - Surgery CPTs with <100 observations (n=58,753)
  - Surgeons with <100 observations (n=30,295)

# Sample

- Final Sample
  - 498,234 cases
  - 1,131 surgeons
  - 20 US institutions

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# Statistical Approach

- Primary Outcome: In-Hospital Death or Major Complication
  - Major Complications: Thromboembolic events, MI, stroke, PNA, sepsis
  - Identified by discharge diagnosis codes
- Secondary Outcomes
  - Surgery length (surgery end-surgery start)
  - Death
  - Major complications
  - Minor complications (UTI, SSI)

# Statistical Approach

- Exposure
  - Having operated overnight before the current day' surgery
    - “Overnight” defined as 2300-0700
    - Measured using surgery start and end times
    - Baseline model was yes/no for any overnight operating time
    - Sensitivity analyses examined alternate definitions

# Statistical Approach

- Multivariable Linear Regression
  - Key innovation is use of "surgeon fixed effects"
    - Reduces confounding because we are not comparing surgeons who operate overnight to those who do not
    - Compare a given surgeon's cases where the surgeon operated overnight compared to the cases where the same surgeon did not
  - Additional variables include
    - Patient characteristics (Age, sex, comorbidities)
    - Surgery CPT Fixed Effects
    - Hour of Surgery

# Statistical Analyses

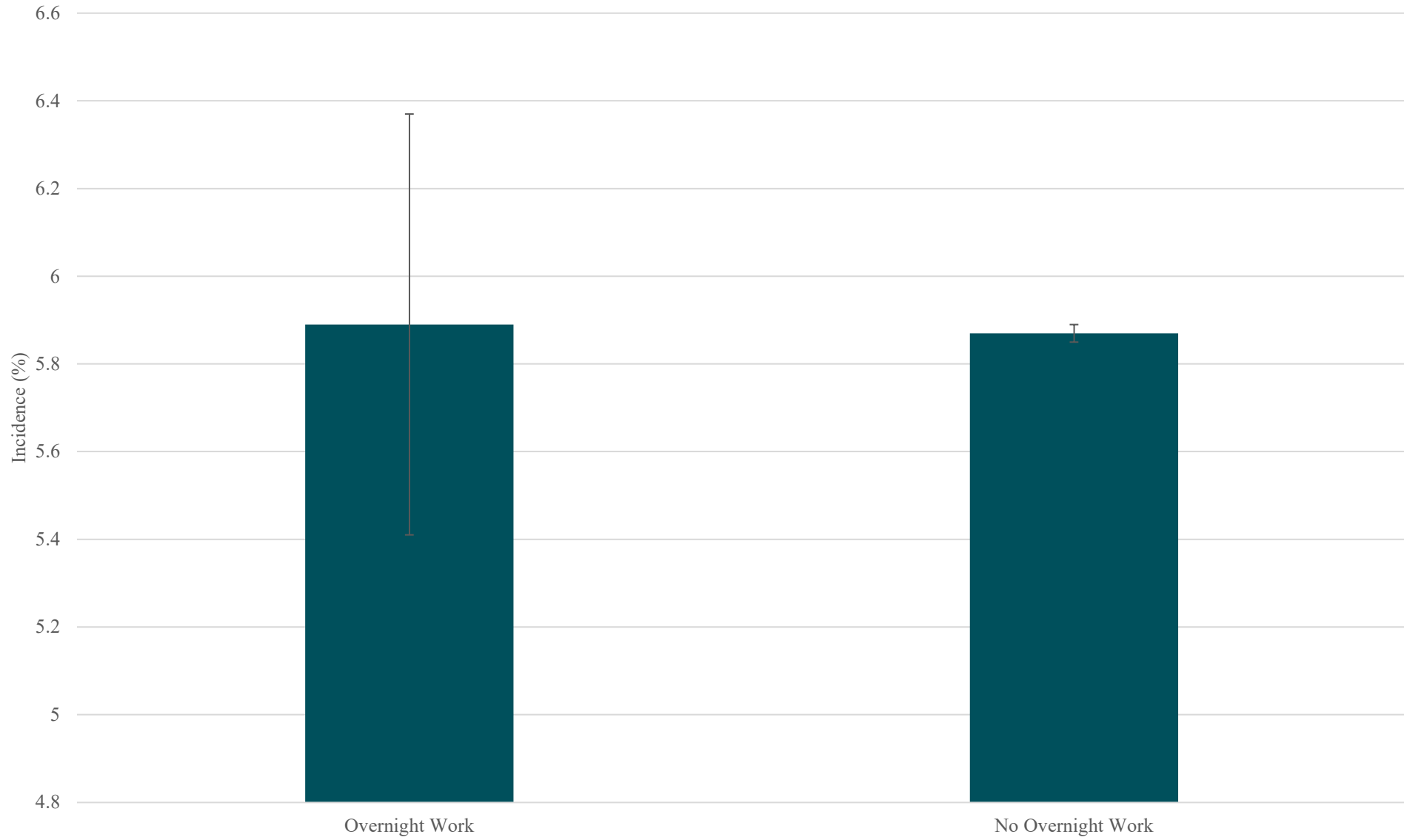
- Subgroup Analysis
  - “High risk” patients → upper 25<sup>th</sup> percentile of predicted mortality/major complication
- Sensitivity Analysis
  - Two alternate approaches to measuring intensity of operating overnight
  - Five groups:
    - no overnight operating
    - 0-2h
    - 2-4h
    - 4-6h
    - 6-8h
  - Introduce hours operated overnight as a linear variable



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	Surgeon Operated the Previous Night (N=13,098)	Surgeon did Not Operate the Previous Night (N=485,136)	p-value/g-value
Patient demographics			
Age, mean (s.e)	53.91 (0.15)	55.32 (0.02)	<0.001/0.09
Male, % (s.e.)	52.32 (0.44)	46.72 (0.07)	<0.001/0.11
Comorbidities, % (s.e.)			
Congestive Heart Failure	8.73 (0.25)	5.32 (0.03)	<0.001/0.15
Arrhythmia	18.46 (0.34)	13.07 (0.05)	<0.001/0.16
Valvular Disease	7.72 (0.23)	5.18 (0.03)	<0.001/0.11
Pulmonary Circulatory Disorders	4.57 (0.18)	2.94 (0.02)	<0.001/0.10
Peripheral Vascular Disease	9.04 (0.25)	5.36 (0.03)	<0.001/0.16
Hypertension, Uncomplicated	32.75 (0.41)	29.38 (0.07)	<0.001/0.07
Hypertension, Complicated	11.70 (0.28)	7.16 (0.04)	<0.001/0.17
Paralysis	1.70 (0.11)	1.08 (0.01)	<0.001/0.06
Neurological Disorder	6.66 (0.22)	4.55 (0.03)	<0.001/0.10
Chronic Pulmonary Disease	14.05 (0.30)	11.61 (0.05)	<0.001/0.08
Diabetes, Uncomplicated	11.66 (0.28)	9.95 (0.04)	<0.001/0.06
Diabetes, Complicated	5.10 (0.19)	3.09 (0.02)	<0.001/0.12
Hypothyroidism	7.66 (0.23)	8.29 (0.04)	0.010/0.02
Chronic Renal Failure	12.35 (0.29)	7.73 (0.04)	<0.001/0.17
Liver Disease	5.47 (0.20)	4.00 (0.03)	<0.001/0.07
Peptic Ulcer Disease	0.73 (0.07)	0.58 (0.01)	0.030/0.02
AIDS	0.41 (0.06)	0.24 (0.01)	<0.001/0.03
Lymphoma	1.00 (0.09)	1.38 (0.02)	<0.001/0.03
Metastatic Disease	6.06 (0.21)	13.99 (0.05)	<0.001/0.23
Solid Tumor	13.83 (0.30)	24.65 (0.06)	<0.001/0.25
Rheumatoid Arthritis	2.79 (0.14)	2.32 (0.02)	<0.001/0.03
Coagulopathy	7.59 (0.23)	4.23 (0.03)	<0.001/0.17
Obesity	16.44 (0.32)	14.96 (0.05)	<0.001/0.04
Weight Loss	5.79 (0.20)	3.81 (0.03)	<0.001/0.10
Fluid or Electrolyte Disorder	17.58 (0.33)	9.94 (0.04)	<0.001/0.25
Blood Loss	1.21 (0.10)	0.85 (0.01)	<0.001/0.04
Iron Deficiency Anemia	2.72 (0.14)	2.07 (0.02)	<0.001/0.05
Alcohol Abuse	1.12 (0.09)	0.66 (0.01)	<0.001/0.06
Drug Abuse	4.21 (0.18)	2.42 (0.02)	<0.001/0.11
Psychosis	0.75 (0.08)	0.51 (0.01)	<0.001/0.03
Depression	11.35 (0.28)	9.95 (0.04)	<0.001/0.05
ASA Score			
Physical Status Score, mean (s.e)	2.62 (0.01)	2.53 (0.00)	<0.001/0.13
Emergent Case, % (s.e.)	8.70 (0.25)	2.60 (0.02)	<0.001/0.37
High-Risk Patients, % (s.e.)	35.9 (0.4)	24.7 (0.1)	<0.001/0.26



## Summary of Outcomes

	<b>Operating Overnight</b>	<b>No Operating Overnight</b>	<b>p</b>
Primary Outcome	5.89	5.87	0.93
Surgery Length (min)	112.7	117.4	0.020
Death (%)	0.87	0.89	0.82
Major Cx (%)	5.40	5.34	0.83
Minor Cx (%)	2.34	2.27	0.67

Hours operated night prior modeled as a categorical variable		
Amount of time worked between 11pm and 7am the previous night	Death or major complication, adjusted % (95% CI)	Absolute adjusted difference (95% CI)
None (N=485,136)	5.87 (5.85 to 5.88)	-
>0 to <2 hours (N=9,117)	6.05 (5.50 to 6.60)	0.18% (-0.38% to 0.75%) p=0.52
2 to <4 hours (N=2,116)	5.47 (4.35 to 6.59)	-0.40% (-1.52% to 0.72%) p=0.49
4 to <6 hours (N=883)	6.01 (4.17 to 7.85)	0.15% (-1.70% to 1.99%) p=0.88
6-8 hours (N=982)	5.21 (3.60 to 6.83)	-0.65% (-2.27% to 0.97%) p=0.43
Hours worked night prior modeled linearly		
Absolute adjusted change in death or major complication per additional hour worked (95% CI)	-0.05% (-0.22% to 0.12%) p=0.57	

## Conclusions

- Surgeons who operated overnight—even for extensive periods of time—did not have worse outcomes when they operated the next day
- Results were robust to a variety of subgroup and sensitivity analyses
- Allowing surgeons who operated overnight to work the next day appears to be safe—at least as it is practiced in this sample of (large) institutions