Exploring Traumatic Brain Injury Mechanisms and Severity Using Electronic Health Records

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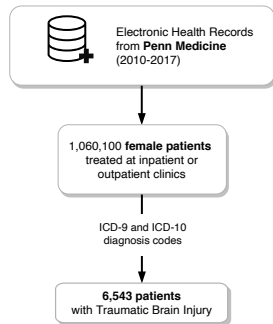DEPARTMENT of BIOSTATISTICS EPIDEMIOLOGY & INFORMATICS

TBI COHORT

This preliminary research describes a cohort of TBI patients within the Penn Medicine health system and the distribution of Traumatic Brain Injury (TBI) **mechanisms and severity**

- TBI definitions were obtained from the Centers for Disease Control & Prevention (CDC)[2] and the U.S. Department of Defense[3]

- Definitions were used to group related ICD codes into injury mechanisms

- ICD codes are specific and can include additional context about the injury

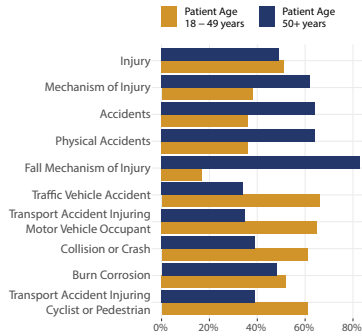Electronic Health Records from **Penn Medicine** (2010-2017)

↓

1,060,100 **female patients** treated at inpatient or outpatient clinics

↓ ICD-9 and ICD-10 diagnosis codes

6,543 **patients** with Traumatic Brain Injury

TBI Patient Cohort Characteristics

Penn Medicine Patient Population	Age Group		
Demographics	Total (%)	18–49 years (%)	50+ years (%)
	6543 (100)	3348 (51)	3195 (49)
Age (years), average:	50 ± 20	33 ± 10	67 ± 12
Race			
White	4,131 (100)	2,079 (50)	2,052 (50)
Black or African American	1,762 (100)	889 (50)	873 (50)
Other	234 (100)	137 (59)	97 (41)
Asian	183 (100)	116 (63)	67 (37)
Unknown	233 (100)	127 (55)	106 (45)
Hispanic Ethnicity	183 (100)	125 (68)	58 (32)
Mixed Race	136 (100)	78 (57)	58 (43)

*To safeguard privacy, the "Other" race category includes "Native Hawaiian or Other Pacific Islander," "American Indian or Alaskan Native," "Mixed Race," and "Other."

TBI MECHANISM BY AGE GROUP

Examples of TBI ICD codes included in Mechanisms

Fall Mechanism of Injury
ICD-10 code V80.010A
Animal-rider injured by fall from or being thrown from horse in noncollision accident, initial encounter

Traffic Vehicle Accident
ICD-9 code E812.4
Motor vehicle traffic accident involving collision with motor vehicle injuring occupant of streetcar

Patient Age 18 – 49 years / Patient Age 50+ years

Mechanisms bar chart (categories): Injury, Mechanism of Injury, Accidents, Physical Accidents, Fall Mechanism of Injury, Traffic Vehicle Accident, Transport Accident Injuring Motor Vehicle Occupant, Collision or Crash, Burn Corrosion, Transport Accident Injuring Cyclist or Pedestrian — axis 0% to 80%

TBI Mechanisms	Age Group		
Mechanism	Total (%)	18–49 years (%)	50+ years (%)
	6543 (100)	3348 (51)	3195 (49)
Injury	6,543 (100)	3,348 (51)	3,195 (49)
Mechanism of Injury	1,517 (100)	581 (38)	936 (62)
Accidents	1,448 (100)	528 (36)	920 (64)
Physical Accidents	1,410 (100)	508 (36)	902 (64)
Fall Mechanism of Injury	900 (100)	152 (17)	748 (83)
Traffic Vehicle Accident	441 (100)	289 (66)	152 (34)
Transport Accident Injuring Motor Vehicle Occupant	413 (100)	268 (65)	145 (35)
Collision or Crash	196 (100)	120 (61)	76 (39)
Burn Corrosion	119 (100)	62 (52)	57 (48)
Transport Accident Injuring Cyclist or Pedestrian	103 (100)	63 (61)	40 (39)

TBI MECHANISM BY SEVERITY

Examples of TBI ICD codes by severity level

Mild
ICD-10 code S06.0X1A
Concussion with loss of consciousness of 30 minutes or less, initial encounter

Severe
ICD-9 code 801.35
Closed fracture of base of skull with other and unspecified intracranial hemorrhage, with prolonged [...] loss of consciousness, without return to pre-existing conscious level

Mild / Moderate / Severe / Penetrating / Unclassified

Severity bar chart (categories): Injury, Mechanism of Injury, Accidents, Physical Accidents, Fall Mechanism of Injury, Traffic Vehicle Accident, Transport Accident Injuring Motor Vehicle Occupant, Collision or Crash, Burn Corrosion, Transport Accident Injuring Cyclist or Pedestrian — axis 0% to 100%

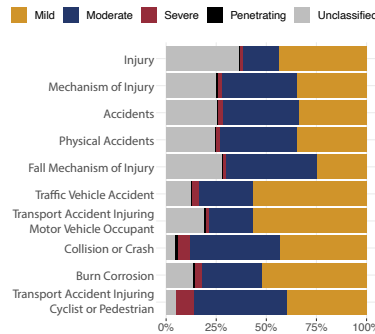| TBI Mechanisms		TBI Severity				
Mechanism	Total	Mild (%)	Moderate (%)	Severe (%)	Penetrating (%)	Unclassified (%)
		5361 (40)	3685 (27)	276 (2.1)	83 (0.6)	3998 (30)
Injury	6,543 (100)	2,865 (44)	1,167 (18)	105 (1.6)	23 (0.4)	2,383 (36)
Mechanism of Injury	1,517 (100)	525 (35)	573 (38)	30 (2.0)	16 (1.1)	373 (25)
Accidents	1,448 (100)	493 (34)	550 (38)	30 (2.1)	12 (0.8)	363 (25)
Physical Accidents	1,410 (100)	489 (35)	543 (39)	29 (2.1)	8 (0.6)	341 (24)
Fall Mechanism of Injury	900 (100)	223 (25)	411 (46)	12 (1.3)	3 (0.3)	251 (28)
Traffic Vehicle Accident	441 (100)	250 (57)	119 (27)	15 (3.4)	4 (0.9)	53 (12)
Transport Accident Injuring Motor Vehicle Occupant	413 (100)	235 (57)	90 (22)	6 (1.5)	4 (1.0)	78 (19)
Collision or Crash	196 (100)	85 (43)	88 (45)	12 (6.1)	3 (1.5)	8 (4.1)
Burn Corrosion	119 (100)	62 (52)	36 (30)	4 (3.4)	1 (0.8)	16 (13)
Transport Accident Injuring Cyclist or Pedestrian	103 (100)	41 (40)	48 (47)	9 (8.7)	0 (0)	5 (4.9)

MOTIVATION

- Often referred to as the "silent epidemic," **Traumatic Brain Injury (TBI)** is a major public health concern contributing to disability and death worldwide[1]

- Most TBI research is limited to male populations, mostly veterans & athletes

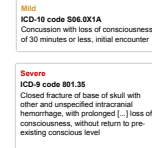- **Electronic health record (EHR)** data can be used to study underresearched populations, including women

PRELIMINARY FINDINGS

- **Injuries relating to falls** occurred mostly among patients in the age group 50 years and older

- **Traffic- and transport-related accidents** occurred mostly among patients between 18 and 49 years

- The **most severe codes** were concentrated in mechanisms related to collisions, crashes, and transport accident injuries

REFERENCES

1. CDC, National Center for Injury Prevention and Control. Report to Congress on traumatic brain injury in the United States: Epidemiology and rehabilitation; 2015.
2. CDC, Traumatic Brain Injury & Concussion, Surveillance Reports 2014-2019
3. DOD, Armed Forces Health Surveillance Division. TBI Appendix II: Code Sets in Excel; 2019.

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