



JP Research Summary: JASIC Flex Injury Estimate

GTR09 PH2 Informal Working Group

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Alliance Concerns

- Appropriateness and validity of the use of PCDS and NASS/CDS data to derive injury estimates by AIS levels for pedestrians.
- Appropriateness of using MAIS 4-6 person-level injury data for pedestrians with tibia fractures which are typically AIS 2 or 3 and estimating fatalities for crash involved pedestrians with tibia fractures.
- Application of historic motor vehicle occupant injury and fatality rates to develop projections of pedestrian injury risk
- Combining several different data bases (FARS, PCDS and NASS CDS/GES) to derive the estimates of fatalities/injuries for tibia fracture

JP Research

Why JP Research

- Independent third party
- JP Research, Inc. is a worldwide research consulting firm specializing in statistical, mathematical, engineering and risk analysis, particularly with regard to motor vehicle safety.

Alliance Requested to JP Research:

- Examine the data and methodology used in the GTR9-2-07r1 and GTR9-2-12 documents
- Provide recommendations on how the available field data could be used to estimate the number of fatalities and injuries associated with tibia fractures

PCDS Evaluation

NASS Pedestrian Crash Data Study (PCDS):

- PCDS data is based on 6 major cities across the U.S.
 - PCDS is a small data set with only 404 pedestrians aged 16 years and older
- Vehicles are predominantly model years 1990 through 1996.
 - Over 60% Passenger cars
 - 20 – 25 % Sport utility vehicles, pick-up and vans
- The U.S. vehicle fleet has changed significantly in the last decade:
 - 40% of today's vehicle population are Sport utility, pickups and minivans
- This data is not representative of the current U.S. fleet mix and consequently the PCDS data may not be a statistically valid sample of pedestrian related crashes/fatalities/injuries.

PCDS Evaluation

Table 1a:
PCDS – Pedestrian Injury Severity With and Without Tibia Fracture
(Ages 16 or older)

| MAIS | With Tibia Fracture | With Tibia Fracture Non-Fatal | With Tibia Fracture Fatalities | No Tibia Fracture | No Tibia Fracture Non-Fatal | No Tibia Fracture Fatalities |
|--------------|---------------------|-------------------------------|--------------------------------|-------------------|-----------------------------|------------------------------|
| 1 | 0 | 0 | 0 | 165 | 165 | 0 |
| 2 | 15 | 14 | 1 | 59 | 56 | 3 |
| 3 | 44 | 42 | 2 | 25 | 21 | 4 |
| 4 | 9 | 6 | 3 | 20 | 14 | 6 |
| 5 | 24 | 13 | 11 | 25 | 8 | 17 |
| 6 | 6 | 0 | 6 | 12 | 0 | 12 |
| Total | 98 | 75 | 23 | 306 | 264 | 42 |

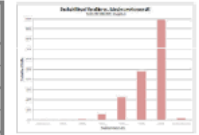
2. Estimation of Cost Reduction due to Tibia Fracture Mitigation GTR9-1-07r1

- Estimated Reduction in Annual Medical Cost (US, JPN) -
Number of Pedestrians Sustaining Tibia Fracture by MAIS

PCDS, age > 15

| MAIS | Total | with Tibia Fracture | without Tibia Fracture |
|------|-------|---------------------|------------------------|
| 1 | 165 | 0 | 165 |
| 2 | 74 | 4 | 70 |
| 3 | 70 | 25 | 45 |
| 4 | 31 | 6 | 23 |
| 5 | 49 | 17 | 32 |
| 6 | 18 | 6 | 12 |

| MAIS | Fatality Ratio |
|------|----------------|
| 2 | 1.0% |
| 3 | 5.3% |
| 4 | 22.5% |
| 5 | 47.6% |
| 6 | 99.0% |



Reference: Goertz A., Accident Statistical Distributions from NAS CDS, SAE Paper #2010-01-0139 (2010)

Percentage of Tibia Fracture by Injury Severity

| Injury Severity | With Tibia Fracture (%) | Without Tibia Fracture (%) |
|-----------------|-------------------------|----------------------------|
| Fatal | 32.7% | 67.3% |
| Severe | 22.0% | 77.4% |
| Minor | 0.0% | 100.0% |

- GTR9-1-07r1 PCDS data separation significantly differs from the JP Research analysis
 - JP found 38 more pedestrians with tibia fractures (mostly with MAIS 2 and 3) than JASIC
- Table 1a shows there were 65 fatalities, 42 without tibia fracture and 23 with tibia fracture
 - Of the 23, only 3 had tibia fracture injuries (2 MAIS 3 and 1 MAIS 2)
 - If the PCDS is used to estimate pedestrian tibia injuries with tibia fracture, these are about 5% (3/65) compared to the 32.7% in GTR9-1-07r1 document

Impact Speed

Figure 2. Impact Speed Distribution

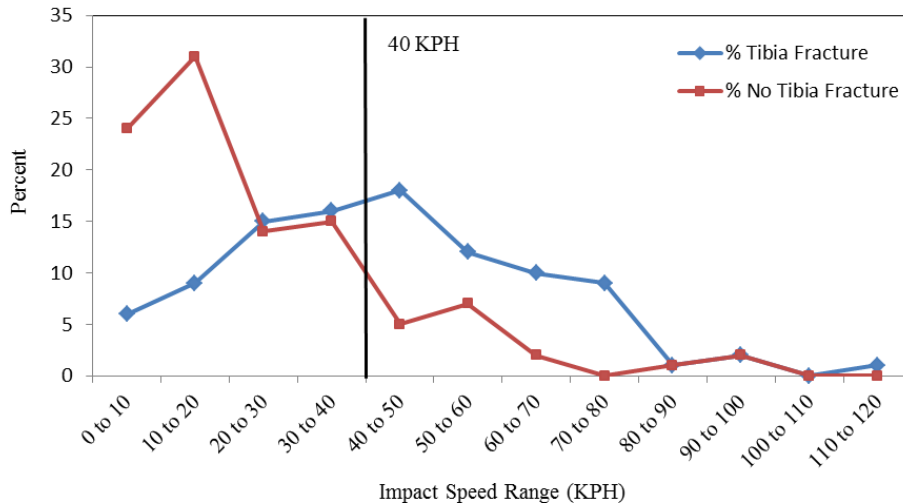
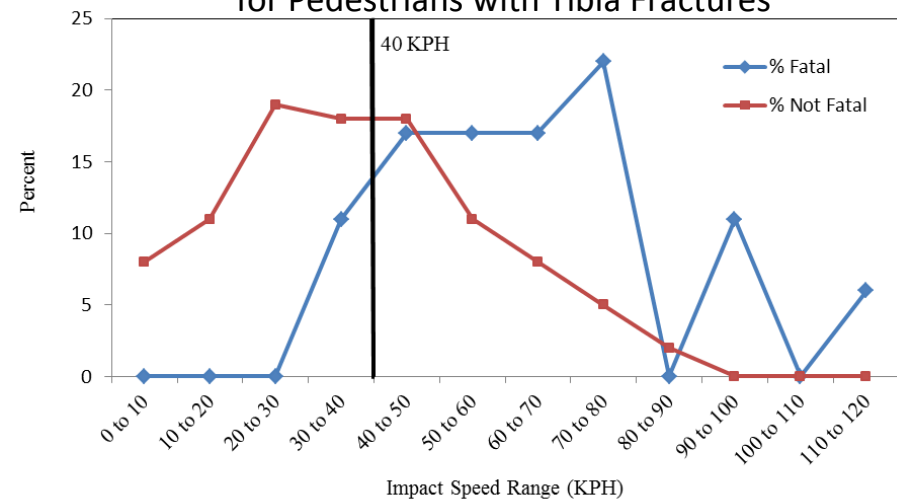


Figure 3. Impact Speed Distribution for Pedestrians with Tibia Fractures

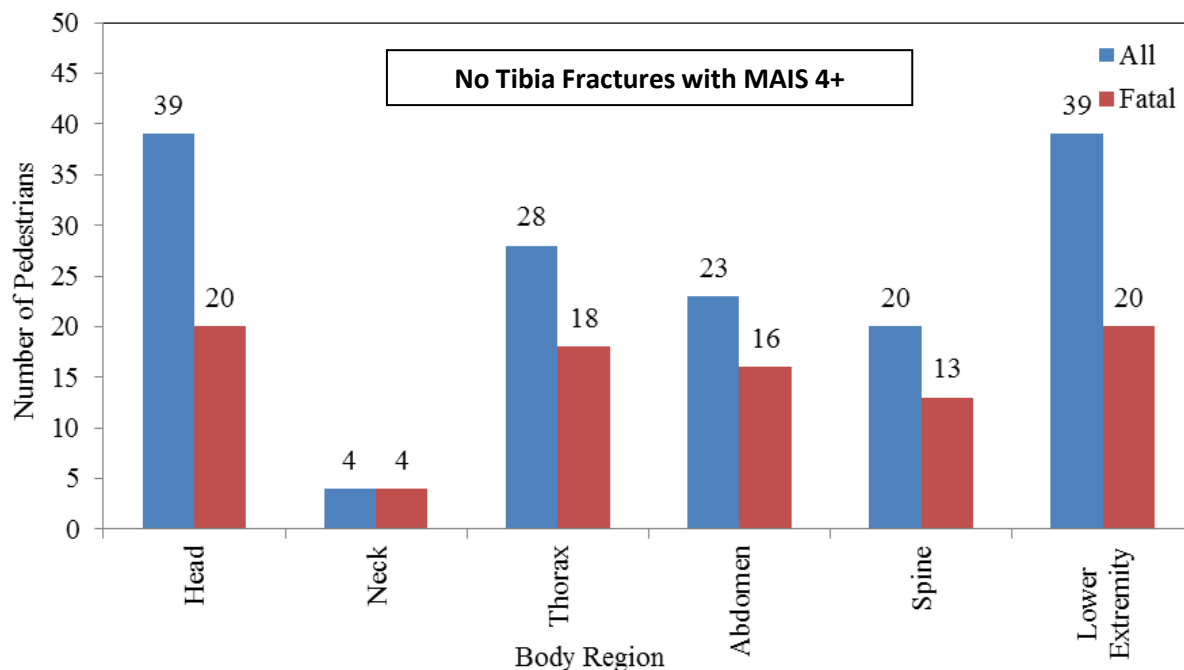


- Impact speed is an important contributor to injury severity for pedestrians interacting with motor vehicles.
- The PCDS data was used to identify the distribution of impact speeds for pedestrians with and without tibia fractures
 - Figure 2: 53% of the pedestrians with tibia fractures were associated with high impact speeds (>40KPH) which implies there could be multiple injuries associated with those crashes
 - Figure 3: 90% of the fatal pedestrians with tibia fractures were involved in crashes with high impact speeds (>40KPH)
 - Both Figures 2 and 3 show the sampling variability due to the small sample of the PCDS data
 - Injury estimates cannot be reliably derived from this PCDS data to represent the injury experience of pedestrians with tibia fractures.

Note: Counts for speeds are up to and including the right end points. E.g. "10 to 20" means speeds greater than 10 and up to and including 20 KPH.

Tibia Fractures with Multiple Injuries

Figure 1a: PCDS - Injury Type by Body Region
(Pedestrians (ages 16+) with Tibia Fractures and Other MAIS 4+ Injuries)



- Figure 1a shows that tibia fractures should not be examined in isolation because those with tibia fractures often suffered from other injuries
 - Of the 98 PCDS who suffered a tibia fracture for impacts less than or equal to 40 KPH, just 2 had only that injury
 - Using injuries from PCDS data to project for national estimate of tibia fracture fatalities will most likely overstate the tibia fracture caused fatalities

Methodology and Approach

The GTR9-1-07r1 estimations relied in part on the SAE Goertz* study which is based on vehicle occupants, *not* pedestrians.

* SAE International Technical Paper 2010-01-0139, "Accident Statistical Distributions from NASS CDS", Goertz A, Yaek J and Compton C, April 12, 2010

2. Estimation of Cost of Tibia Fracture

- Estimated Reduction in Annual

Number of Pedestrians Sustaining Tibia Fracture by MAIS
PCDS, age > 15

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Percentage of Tibia Fracture by Injury Severity

| Injury Severity | With Tibia Fracture (%) | Without Tibia Fracture (%) |
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| Fatal | 32.7% | 67.3% |
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Life Cycle Medical Cost (US, JPN) - Fatality Ratio by MAIS

GTR9-1-07r1

| MAIS | Fatality Ratio |
|------|----------------|
| 2 | 1.0% |
| 3 | 5.3% |
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| 5 | 47.6% |
| 6 | 99.0% |

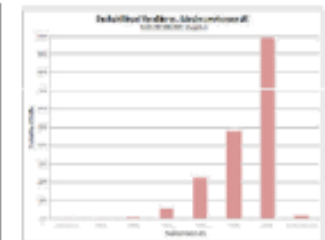


Figure 24. Probability of Fatality vs. Maximum Injury

Reference: Goertz A., Accident Statistical Distributions from NASS CDS, SAE Paper #2010-01-0139 (2010)

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Estimating the probability of fatality for occupants to represent pedestrian risk of fatality is not statistically valid. There are potentially significant differences:

- Impact speeds
- Age group (drivers/pedestrians)
- Nature of tibia fractures are different between vehicle occupants and pedestrians interacting with a vehicle

Combining Databases

- The methods used in GTR9-2-07r1 and GTR9-2-12 combines several different data bases---FARS, PCDS, NASS-CDS, and GES--- to derive the estimates of fatalities with and without tibia fractures
 - The data collection, sampling methods and representation of these data bases are substantially different and thus cannot be easily combined to make national projections for tibia fracture.
 - In the PCDS codebook it states, “Unlike other NASS datasets the PCDS data is not a statistical sample and, therefore, there are no case weight variables.”
- PCDS cannot be used in direct combination with data sources which were based on stratified sampling plans which included the entire U.S. (NASS-CDS and GES data).
- The conclusions drawn from PCDS are only valid in the limited context of the 6 sites and the time frame of data collection.

Summary

- The PCDS data is a small sample set
 - Deriving tibia fracture injury and fatality estimates using such small samples for the U.S. as a whole is not statistically valid and subject to uncertainty.
- Impact speed is an important contributor to injury severity for pedestrians interacting with motor vehicles.
 - GTR9-2-07r1 and GTR9-2-12 did not consider vehicle speed
 - In the PCDS data, 90% of the fatal pedestrians with tibia fractures were involved in crashes with high impact speeds (>40KPH)
- The methods used in GTR9-2-07r1 and GTR9-2-12 for estimating tibia and non tibia fracture injuries and fatalities from the PCDS data leads to potentially unrealistic national projections.
 - The approach to combine data sets that are census (FARS), stratified sample (GES) and tow-away crashes from a stratified sample (CDS) with a convenience sample (PCDS) is statistically invalid.