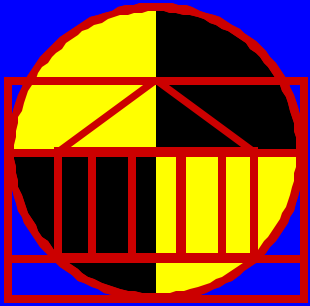


Inova Regional Trauma Center



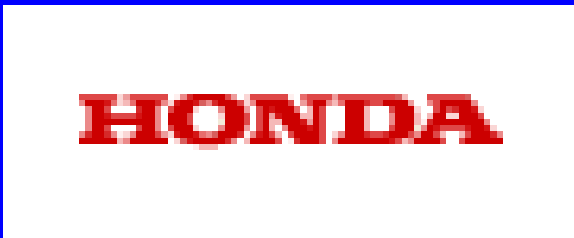
**Inova Fairfax Hospital
Falls Church, VA**



University of
Virginia



Honda Inova Fairfax Hospital CIREN Team



Team Members:

- Samir M. Fakhry, MD, Principal Investigator
- Anne Rizzo, MD, Co-Principal Investigator
- Refaat Hanna, M.D., M.A., Epidemiologist
- Christine Burke, CIREN Study Coordinator
- Greg Stadter, Crash Reconstructionist
- Rodney W. Rudd, Ph.D. CIREN Study Consultant
- Christopher Sherwood, Auto Safety Lab, University of VA
- Capt. Christine Woodard, Fairfax County Fire and Rescue
- Detective J.J. Banachoski, Fairfax County Police CRU
- Lt. Scott McLean, Prince William County Fire and Rescue



Pedestrian Injuries: Analysis of the Burden with Case Illustrations



CIREN Pedestrian Study Objectives

- Address the unmet needs of the “walking” population
- Identify patterns of injuries among pedestrians to better understand mechanism of injury and develop efficient prevention methods
- Identify vehicle features that cause or mitigate injuries
- Educate pre-hospital healthcare providers to conduct on-scene triage based on specific crash criteria and injury criteria



Burden of Pedestrian Injuries

- Each year in the United States, there are 8,000 pedestrians killed and another 100,000 injured in traffic crashes.
- This accounts for 13% of the nation's total traffic fatalities and 5% of injuries (FARS, NASS, GES).
- On average, a pedestrian injury occurs every six minutes and a pedestrian fatality occurs every 107 minutes in the United States (1).
- The proportion of pedestrian fatalities is a greater concern in many other countries, such as Japan, where pedestrians account for nearly 27% of total traffic fatalities, and in Europe, where the percentage reaches nearly 30% in the United Kingdom (2)

(1) 1. U.S. Department of Transportation, National Highway Traffic Safety Administration, 2000.

2. Jason A. Stammen Roger A. Saul, National Highway Traffic Safety Administration



**Pedestrian Injuries
in the
Washington DC Metropolitan
Region
(DCMR)**



Honda Inova Fairfax Hospital CIREN Center

For the purposes of this study, the DC Metro Region (DCMR)

is defined as the counties and municipalities of:

- Virginia (*Northern Virginia*)
- District of Columbia (*DC*)
- Maryland (*Central Maryland*)

The following data sets were available and analyzed for the years 1999-2004:

- Police car crash data
- Injury related hospital discharge data
- Injury mortality data
- The rates are calculated using 2000 population data obtained from US Census Bureau.



Summary

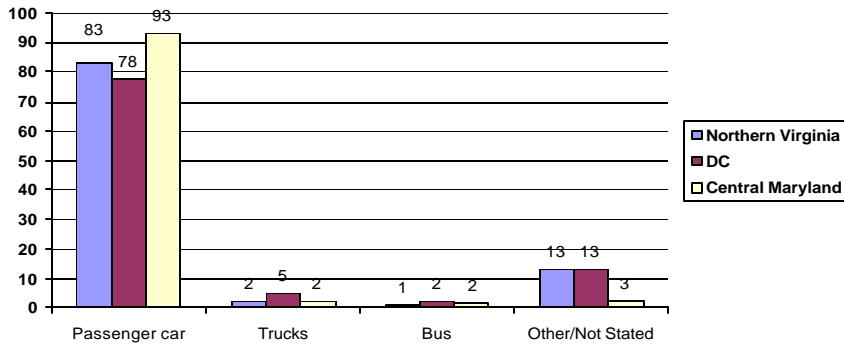
- Approximately 3000 pedestrians are involved in crashes with motor vehicles every year in the DC Metro region.
- The vast majority (92%) sustained one or more injuries.
- A significant percentage of these (17%) required hospitalization of 24 hours or longer.
- Average hospital charges of \$17,000 to \$30,000 per patient depending on the region.

-
- ~~Approximately 80 pedestrians die each year.~~

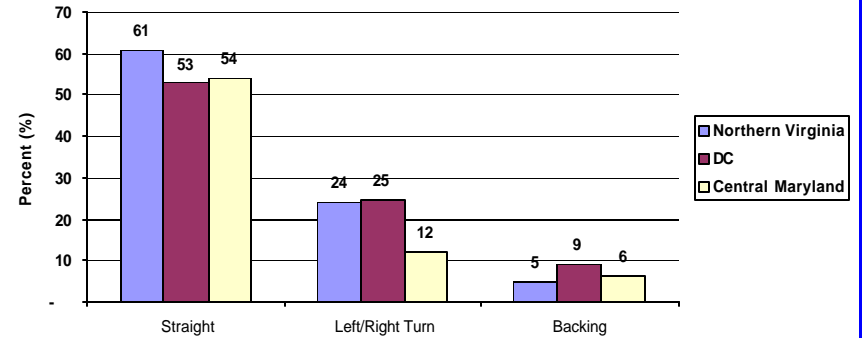


Honda Inova Fairfax Hospital CIREN Center

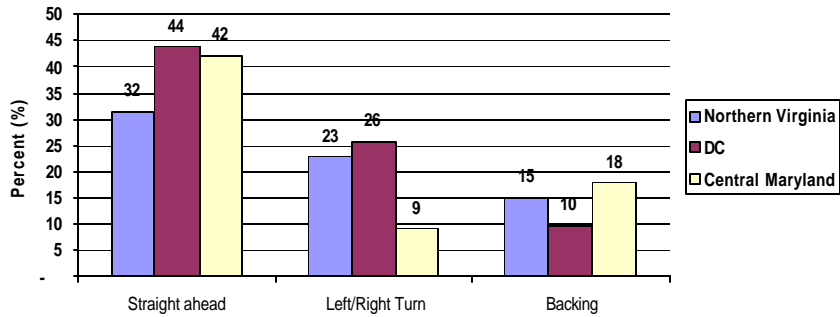
Pedestrian Crashes by Vehicle Type



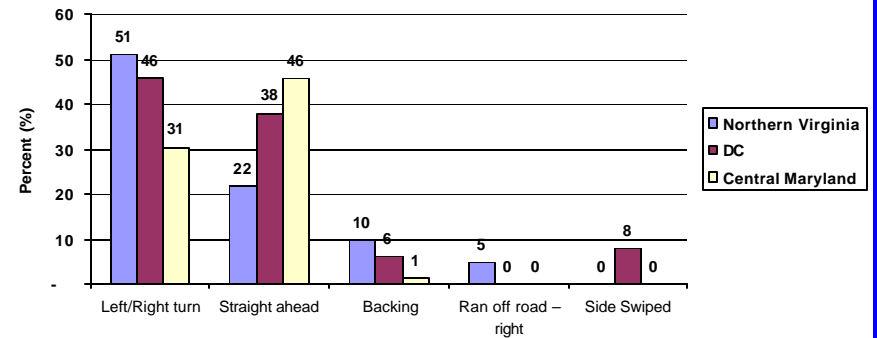
Pedestrian Crashes by Passenger Vehicle Maneuver



Pedestrian Crashes by Trucks Maneuver



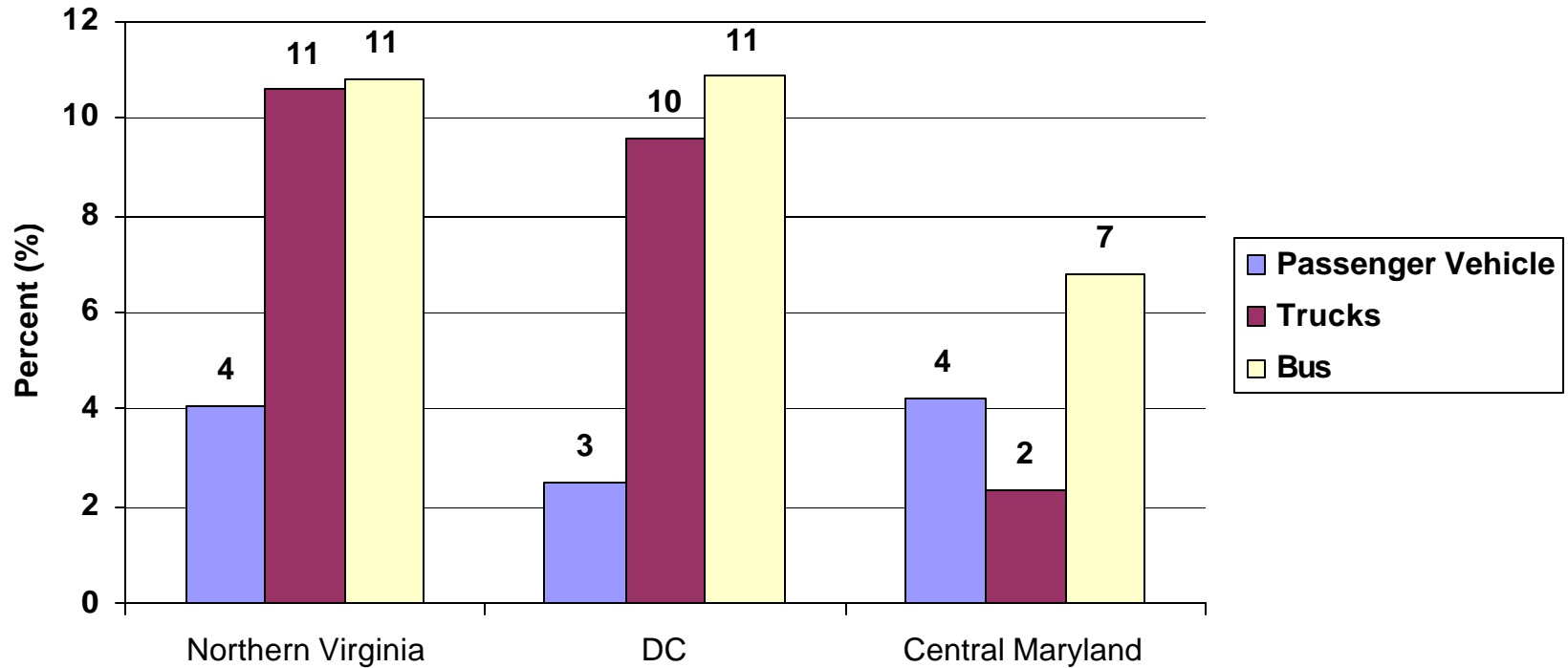
Pedestrian Crashes by Buses Maneuver



Making left or right turn was the most common maneuver prior to pedestrian crashes by buses in both Northern Virginia and DC



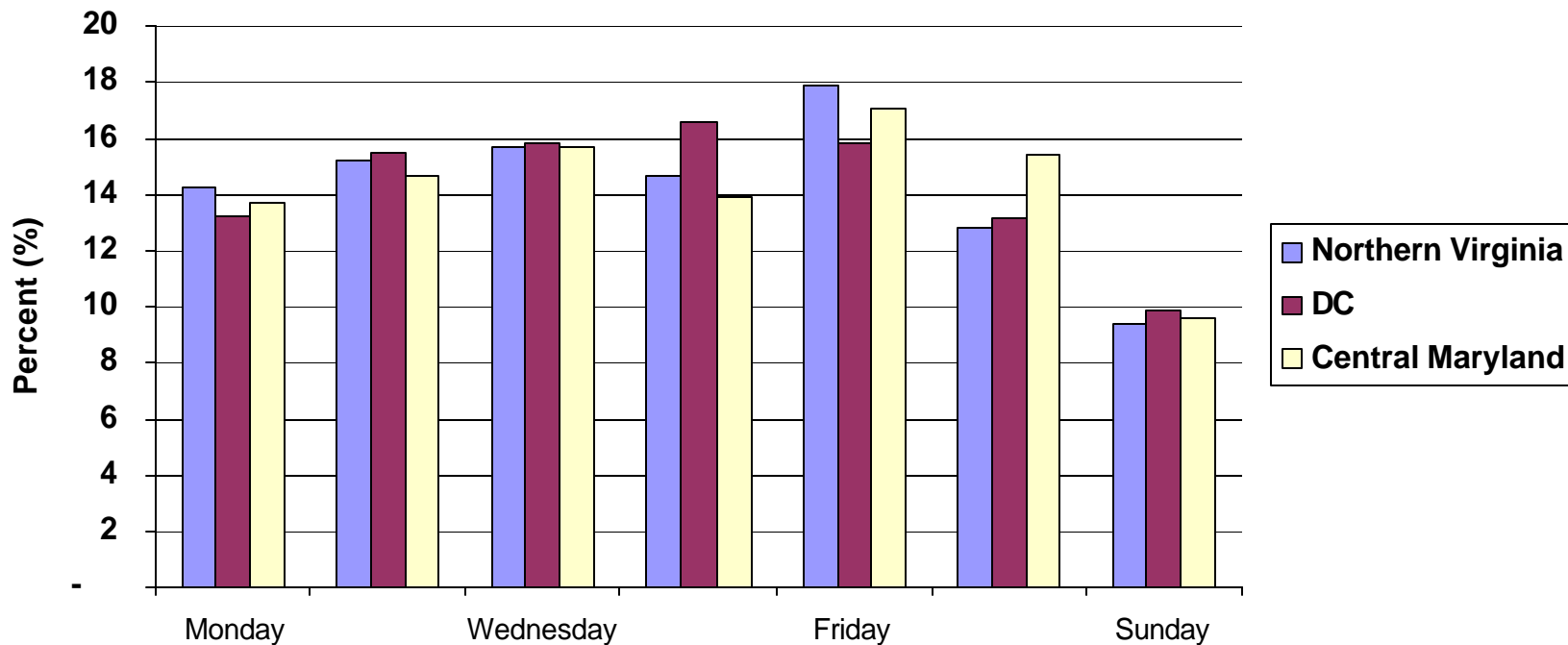
Mortality by Vehicle Type



Pedestrian crashes involving trucks and buses resulted in 11% and 10% mortality in both Northern Virginia and DC respectively



Pedestrian Crashes by Day of the Week

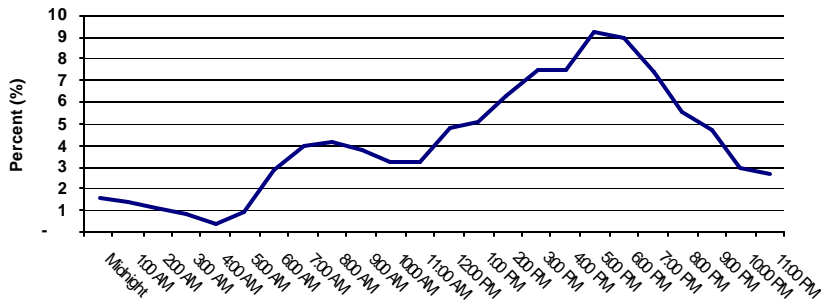


Pedestrian crashes are higher during weekdays with the peak on Friday (Northern Virginia and Central Maryland)

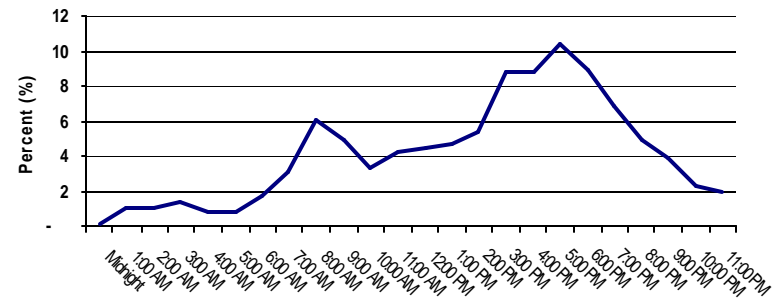


Time of the Crash

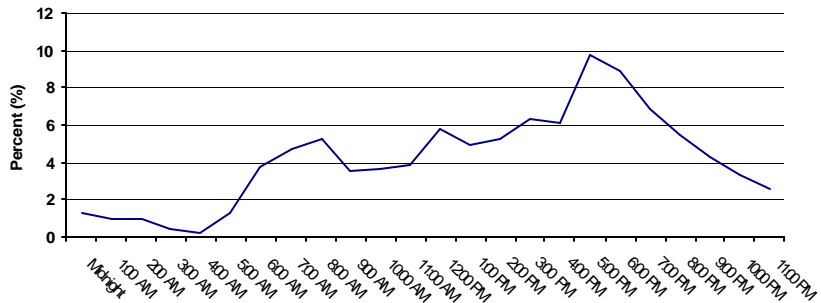
Pedestrian Crashes by Time of Day
Central Maryland 2000 to 2003



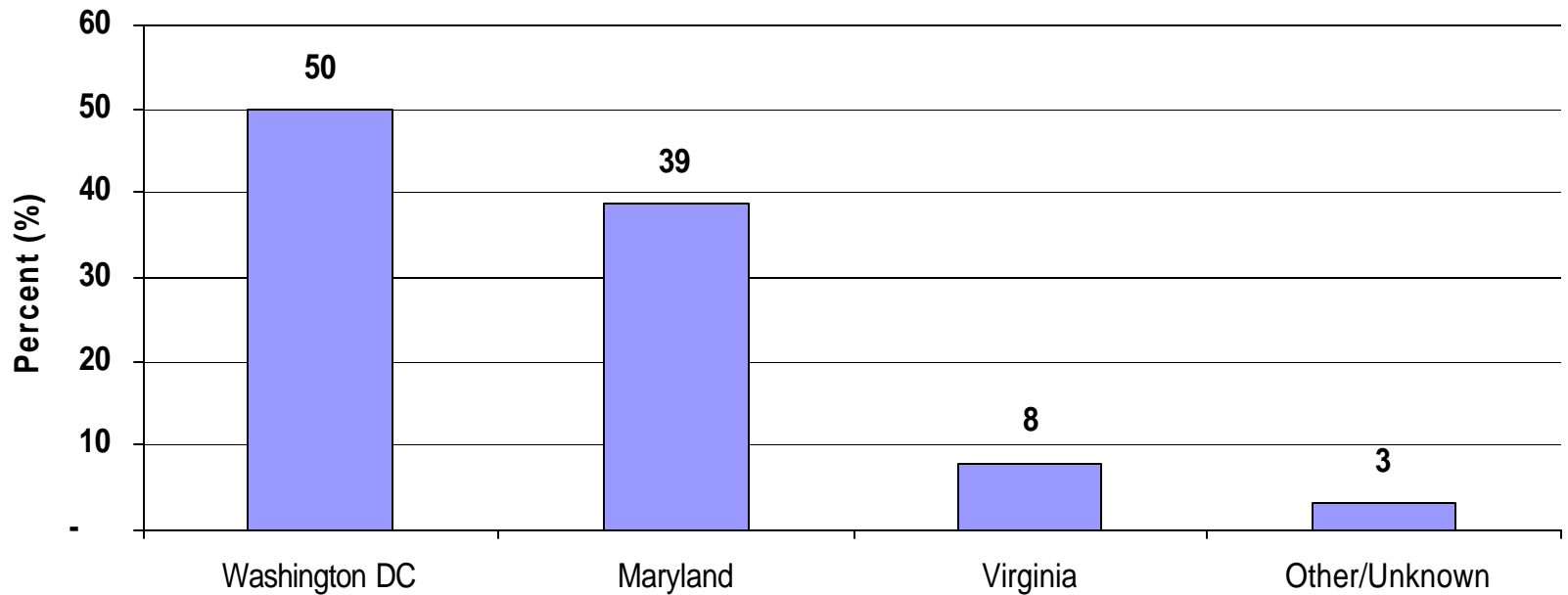
Pedestrian Crashes by Time of Day
DC 2000 to 2004



Pedestrian Crash by Time of Day
Northern Virginia Police Crash Data 1999 to 2003

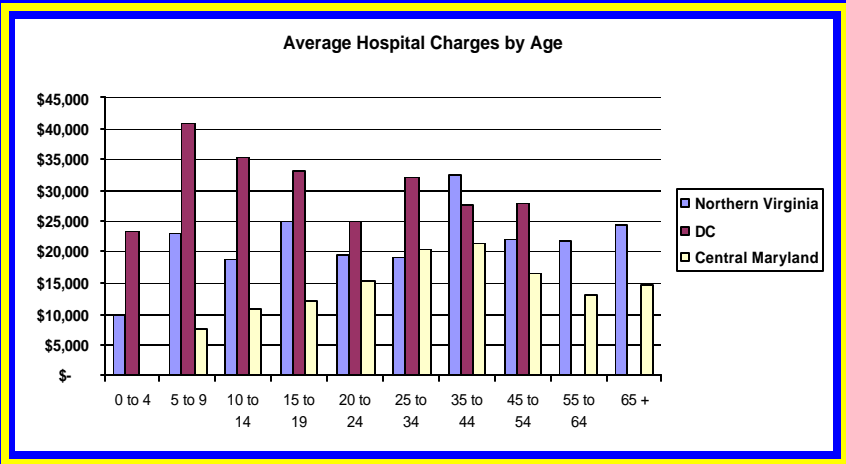


Pedestrian Injury Hospitalizations by State of Residence DC 2001 - 2002

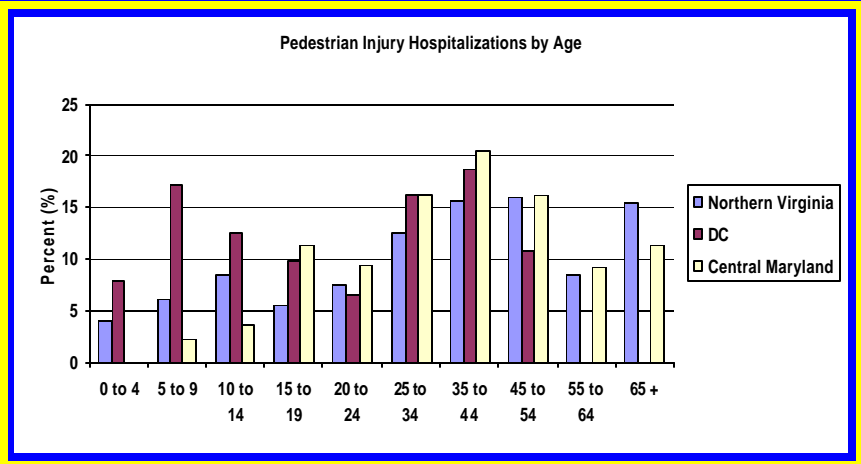


Fifty-percent of the pedestrian injured in Washington DC are non-residents of the city

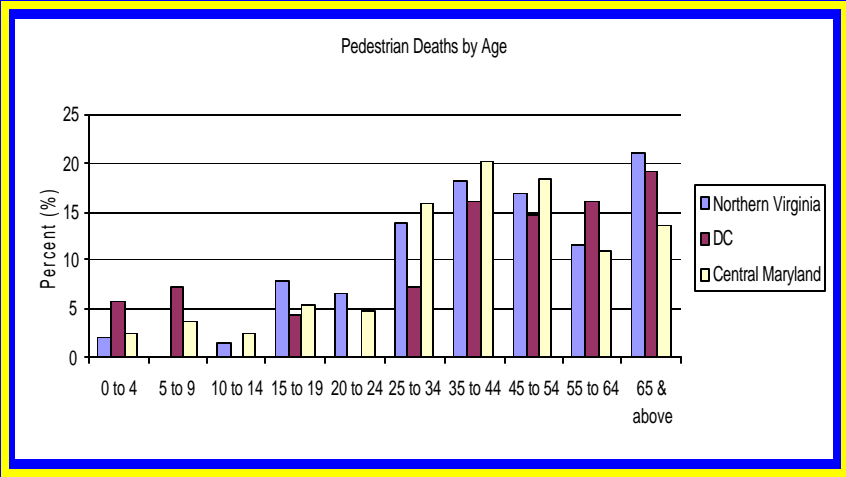




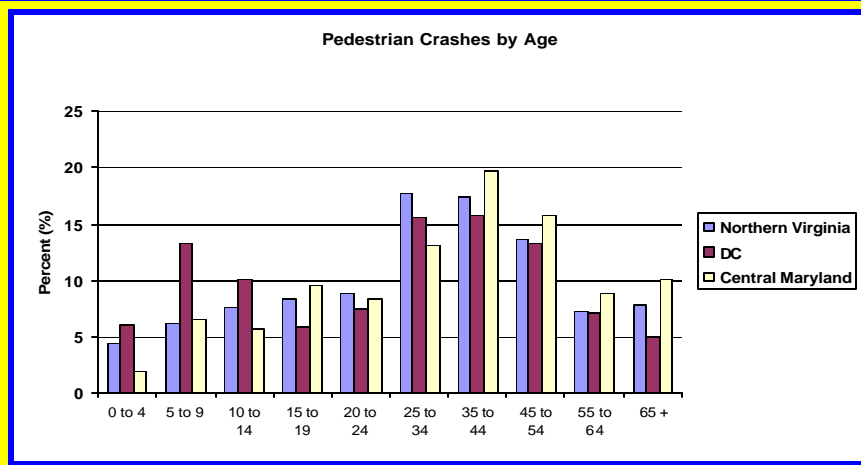
Children in DC aged 5 to 9 years were more than twice as likely as the same age group in both Northern Virginia and Central Maryland to be involved in a pedestrian crash



In Washington DC, pedestrian hospitalizations are significantly higher among children aged 0 to 9, compared to the same age group in both Northern Virginia and Central Maryland



In Washington DC, pedestrian deaths are significantly higher among children aged 0 to 9, compared to the same age group in both Northern VA and Central MD

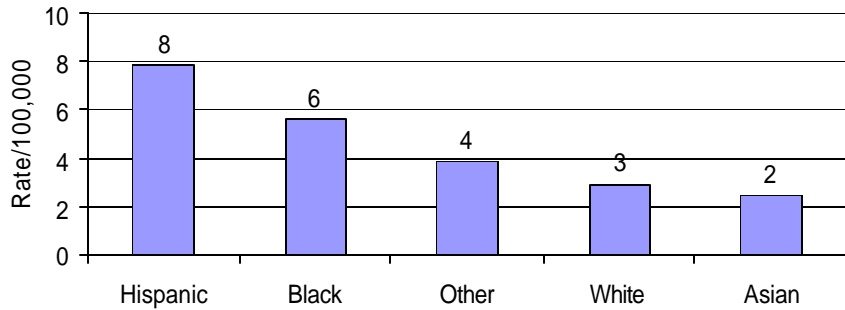


In Washington DC, hospital charges are significantly higher for children aged 5 to 14 years

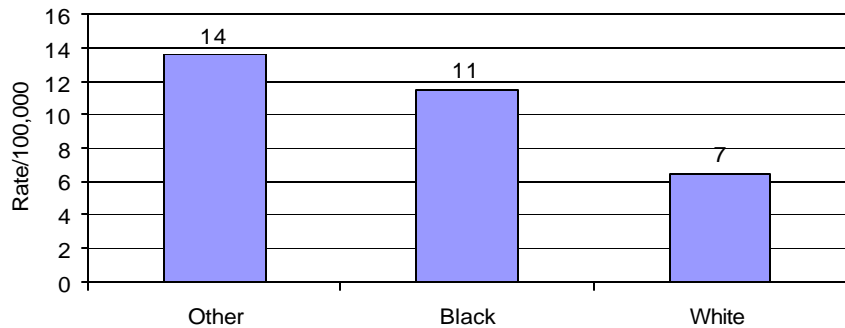


Pedestrian Injury By Race

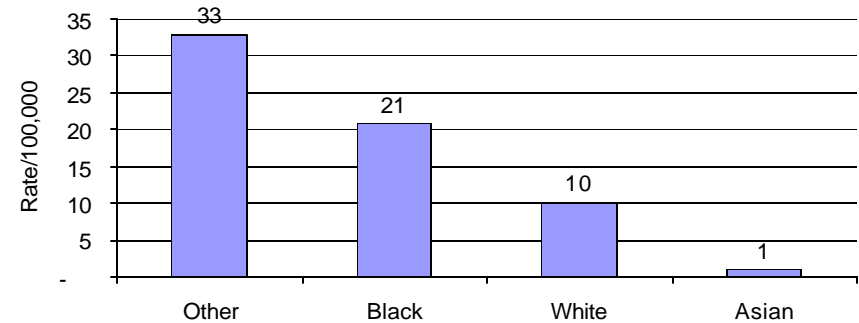
Pedestrian Injury Hospitalizations by Race
Northern Virginia 1999 to 2003



Pedestrian Injury Hospitalizations by Race
Central Maryland 2000 - 2003



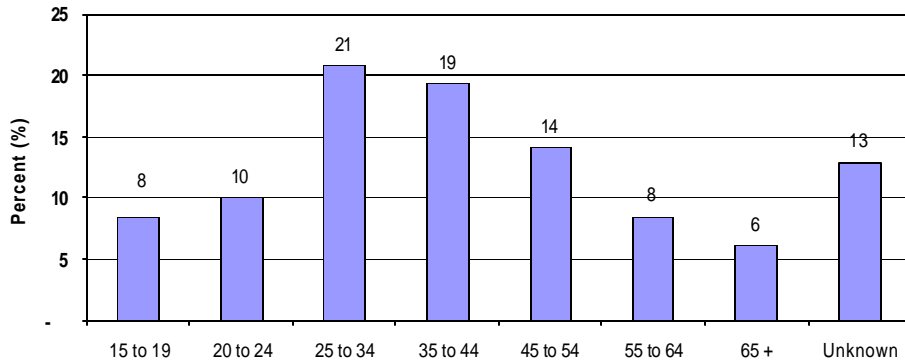
Pedestrian Injury Hospitalizations by Race
DC Residents Only 2001 to 2002



“Other” Races refers to: Hispanics, Native Hawaiian, Pacific Islander, American Indian, Alaska Native, Middle Eastern and Asians (in Central Maryland)

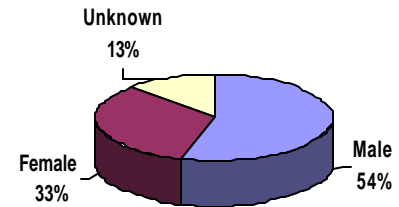


Age of Drivers
Northern Virginia 1999 to 2003

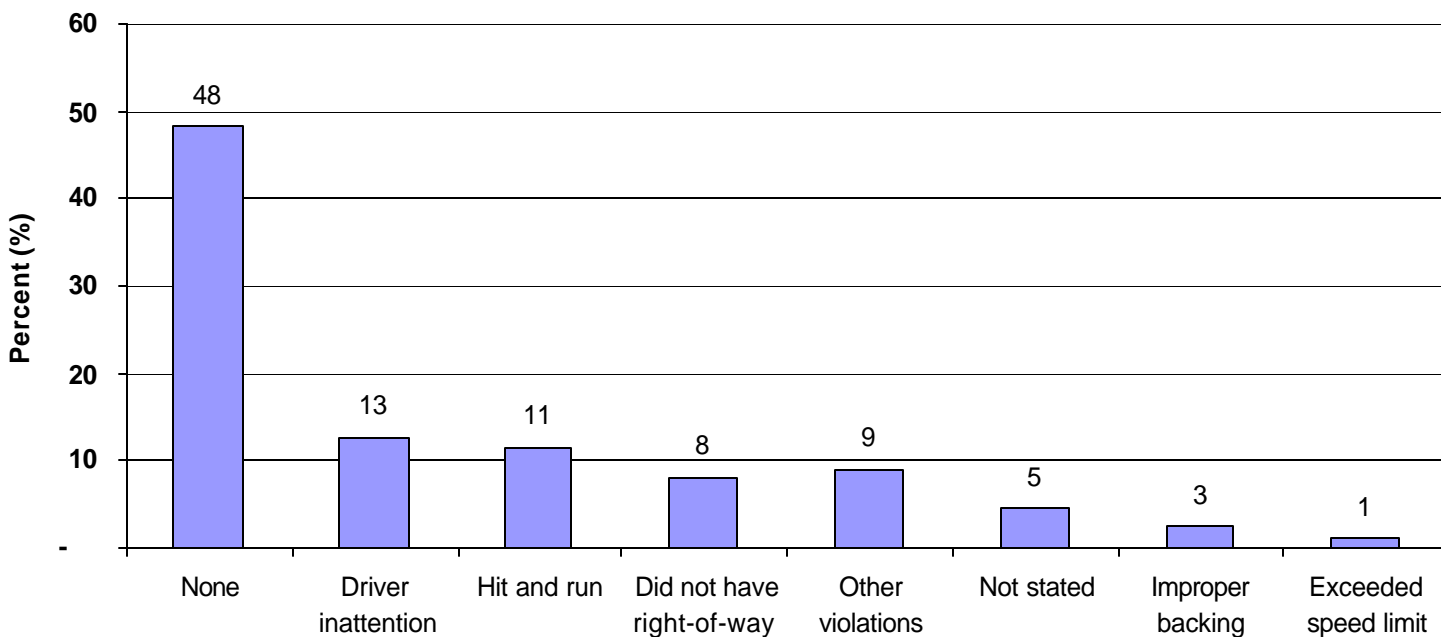


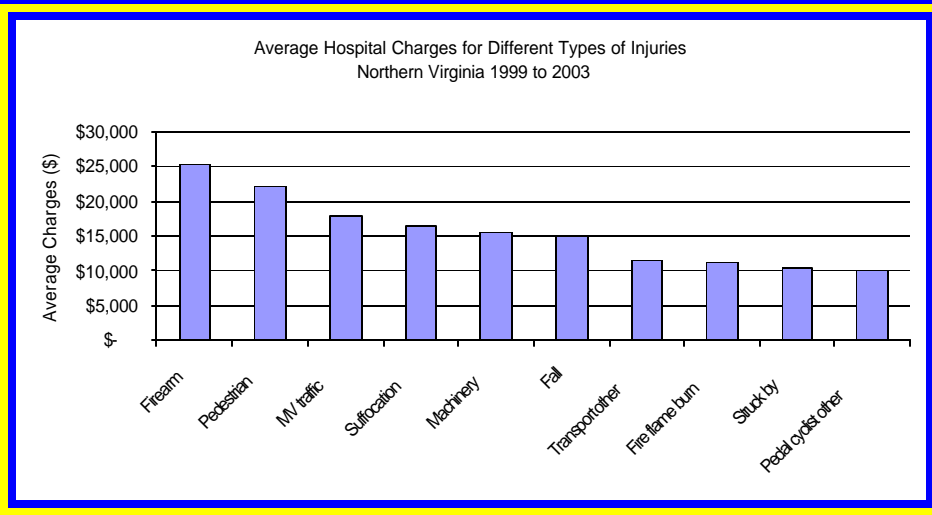
Young drivers aged 15 to 24 were the third highest age group to be involved in pedestrian crashes

Gender of Drivers
Northern Virginia 1999 to 2003

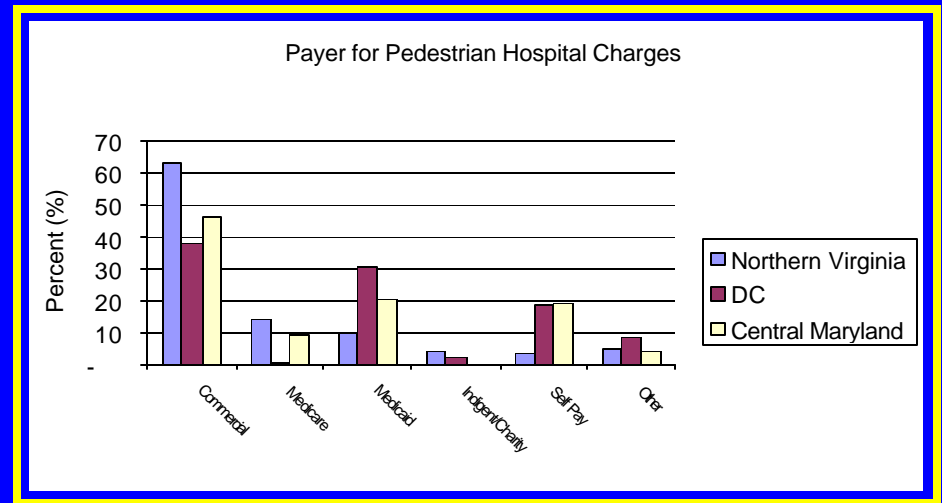


Drivers Violation Prior to Pedestrian Crash
Northern Virginia 1999 to 2003





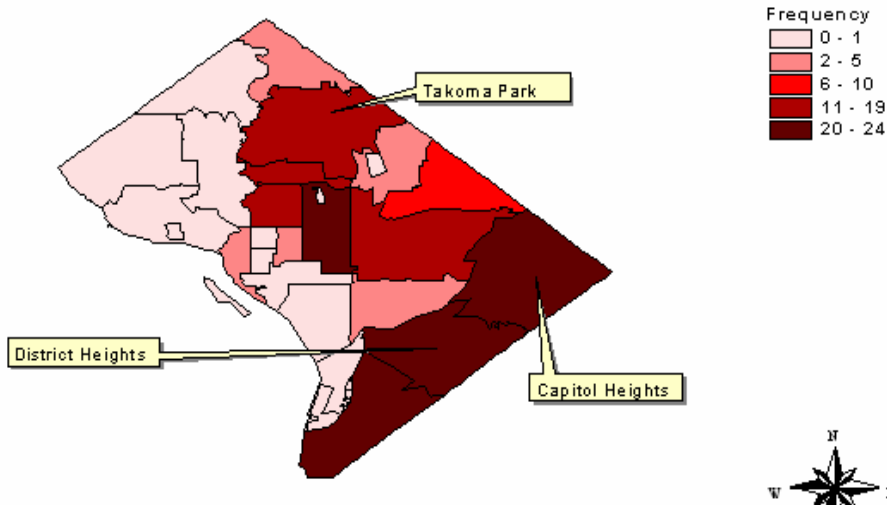
Pedestrian Injuries are the second most costly injuries after firearms



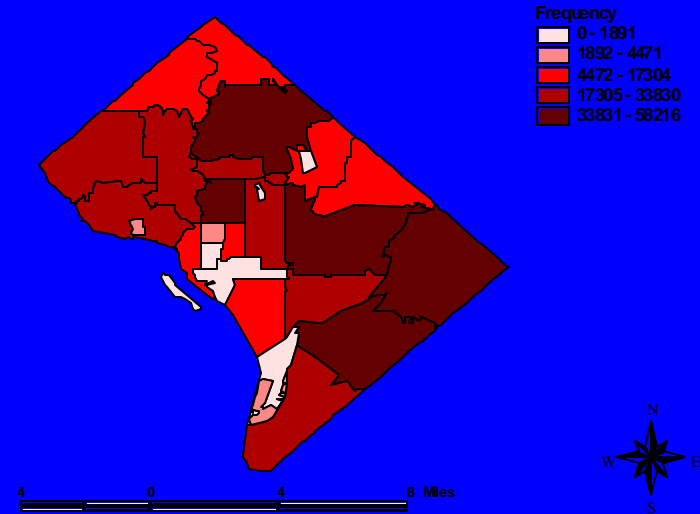
Medicaid and Self-Pay accounted for about 50% of payers in both Washington DC and Central Maryland



Pedestrian Injury Hospitalizations by Zip Code of Residence, Washington DC 2001-2002

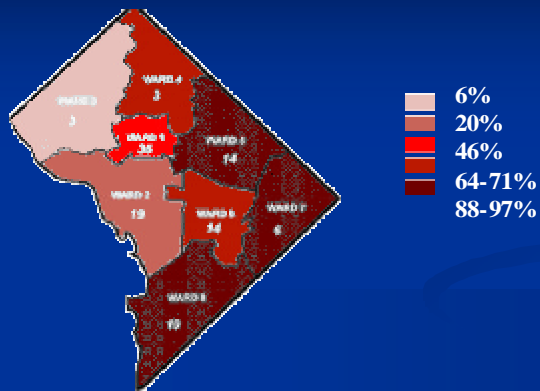


Population Density Washington DC 2001



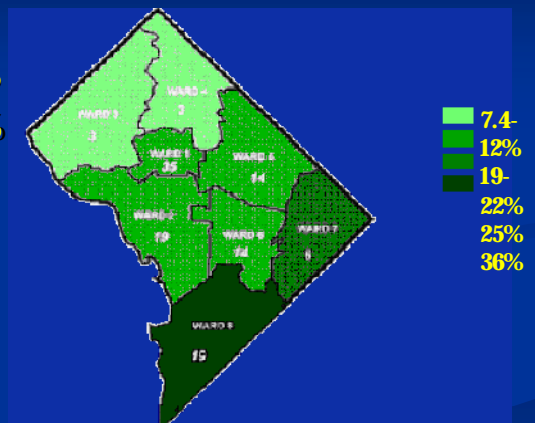
Source: Inova Regional Trauma Center

D.C. African American Population



D.C. Poverty

- Poverty rate 16.9%
 - National Avg.: 12.5%
- Unemployment 7.7%
 - National Avg.: 5.8%



Source: Center for Social Justice Research, Teaching and Service. 2000. *DC Maps*.

Methodology

- Case Selection Criteria
 - Admitted to the trauma center
 - MAIS 2+ injury
 - Struck by the front of the vehicle
 - Upright when struck
 - Hit by a passenger car, SUV, minivan or small pickup truck
 - Pedestrians struck by a large vehicle such as a bus or tractor trailer, were run over or were sitting/lying down when they were struck are excluded from the study



Methodology

- Enrollment & Consent
 - Eligible patients and families are approached by hospital personnel to obtain “Informed Consent”
 - Police contacted to obtain a crash report to identify vehicle owner/driver
 - Vehicle owner is visited to obtain “Informed Consent”
 - Medical information and vehicle information is required to complete case



Methodology

- Data Collection
 - Medical
 - Pre-crash data from EMS reports and interviews
 - Full hospital medical records
 - Patient interview
 - Photographs of injuries
 - Anthropometric measurements
 - 6 & 12 month follow-up health survey
 - Injuries & procedures are reviewed and coded
 - AIS, ICD-9, CPT codes



Methodology

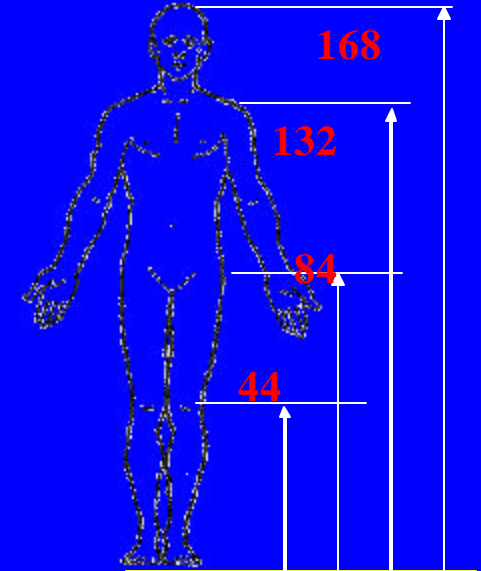
- Data Collection
 - Vehicle & Crash
 - Data is collected along Pedestrian Crash Data Study (PCDS) protocols
 - Police report (vehicle & owner information, scene diagram & photos)
 - Impact speed estimation (skid mark analysis, throw distance calculation)
 - Vehicle inspection (damage/deformation profile, contact marks)



Methodology

- Reconstruction & Simulation

- MADYMO multi-body modeling
 - Pedestrian Model (anthropomorphic measurements)
 - Vehicle Model (facet or ellipsoid model, UVA database)
- Simulation Matrix
 - Multiple orientations & speeds to match witness marks and injury outcome



Component Contacted	Body Region	Evidence
Hood edge	Hip	Bent
A pillar	Shoulder	Scratched
Windshield	Head	Broken
Left side folding mirror	Shoulder	Broken/bent



Challenges

- Case Enrollment
 - 47 Cases Investigated
 - Socioeconomic challenges
 - Homelessness
 - Physiological and dependency issues
 - Legal concerns & other repercussions
 - Inability to consent
 - Vehicle owner consent is very difficult
 - Concerned about legal issues
 - Guilt over the event
 - Vehicles are often repaired soon after the event
 - Necessary to inspect the vehicle
 - Currently necessary vehicle data and photos are obtained from police when inspection is not possible



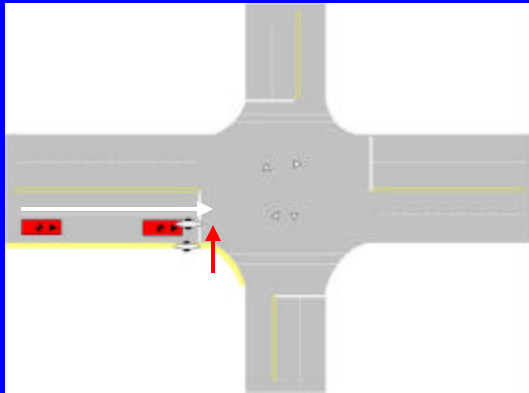
Case Illustrations



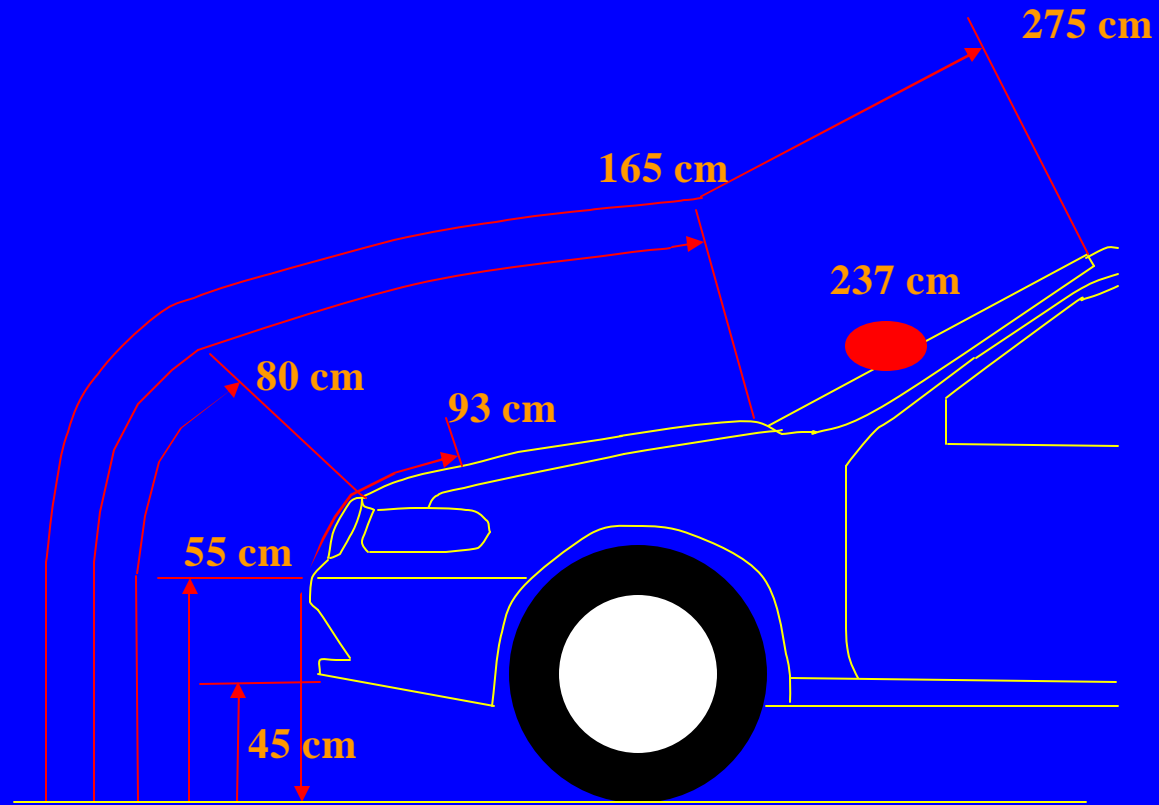
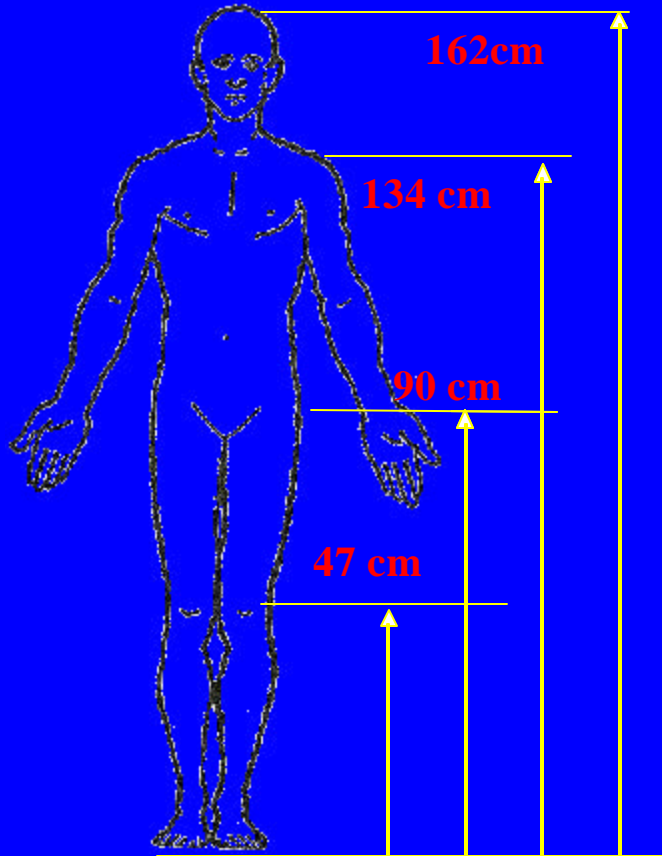
Honda Inova Fairfax Hospital CIREN Center

Case #1

- Male age 17 attempting to cross at an intersection against the light at 22:40. Clear & dry condition on a Saturday evening in the fall.
- Driver of 2003 Chrysler Town & Country van did not observe pedestrian until impact.
- The pedestrian was struck on his left side.



Pedestrian Wrap Measurements



Honda Inova Fairfax Hospital CIREN Center

Vehicle



Component Contacted	Body Region	Evidence
Front bumper	Leg	Cracked
Headlight	Hip	Cracked
Hood edge	Hip	Bent
Front fender top surface	Hip	Bent
Front fender top surface	Hip	Scratched
A pillar	Shoulder	Scratched
Windshield	Head	Broken
Left side folding mirror	Shoulder	Broken/bent
Front fender top surface	Shoulder	Dented



Honda Inova Fairfax Hospital CIREN Center

Case Summary:

- On scene: pedestrian unconscious, fixed and dilated pupils,
- Transported by air to the trauma center - intubated by flight crew
- In trauma bay: pupils sluggishly reactive but equal, GCS 3T
- Physical examination notable for:
 - positive for alcohol consumption, contusions lower extremities
- Radiological examination significant for:
 - left frontoparietal and temporal subdural hematoma
 - right subdural and frontotemporal contusion
 - left lateral superior and inferior pubic rami & acetabulum fractures
- To OR for:
 - right-sided hemicraniectomy
 - evacuation of subdural hematoma
 - debridement of contused brain



Case Summary (continued):

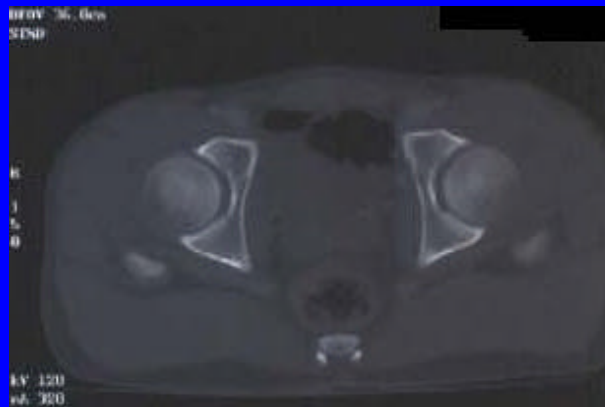
- Admitted to TICU, remained intubated & sedated on TBI protocol
- HD # 5 underwent tracheostomy and PEG
- Slowly improved, sedation weaned down, to IMC on HD # 7
- Neurological status slowly improving, to floor on HD # 10
- Received cognitive evaluation along with PT and OT
- Returned to OR on HD # 58 for cranioplasty - reimplant bone flap
- Due to financial issues could not be transferred to rehabilitation
- Discharged home with family on HD # 62
- RLAS at discharge was VI; able to communicate in his native language, following some commands, able to ambulate with some assistance, able to eat a regular diet
- Hospital Charges: \$151,736



Injuries (ICD)	AIS Severity	Info Source	Aspect (R,L,bilat,etc)	Contact Area (door, seat,etc)
Subdural hematoma (852.25)	140654.5	CT	Right Left	A-Pillar & contra coup injury
Temporoparietal contusion (851.05)	14608.4	CT	Right	A-pillar – contra coup injury



Injuries (ICD)	AIS Severity	Info Source	Aspect (R,L,bilat,etc)	Contact Area (door, seat,etc)
Hip contusion (924.01)	890402.1	Exam	Left	Fender
Pubic rami fracture (808.2)	852602.2	CT	Left – superior & inferior	Fender
Acetabulum fracture (808.0)	852602.2	CT	Left	Fender

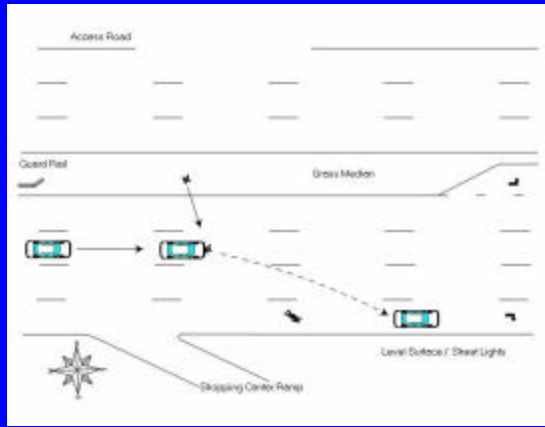


Injuries (ICD)	AIS Severity	Info Source	Aspect (R,L,bilat,etc)	Contact Area (door, seat,etc)
Knee abrasion (916.0)	890202.1	Exam	Right	Ground

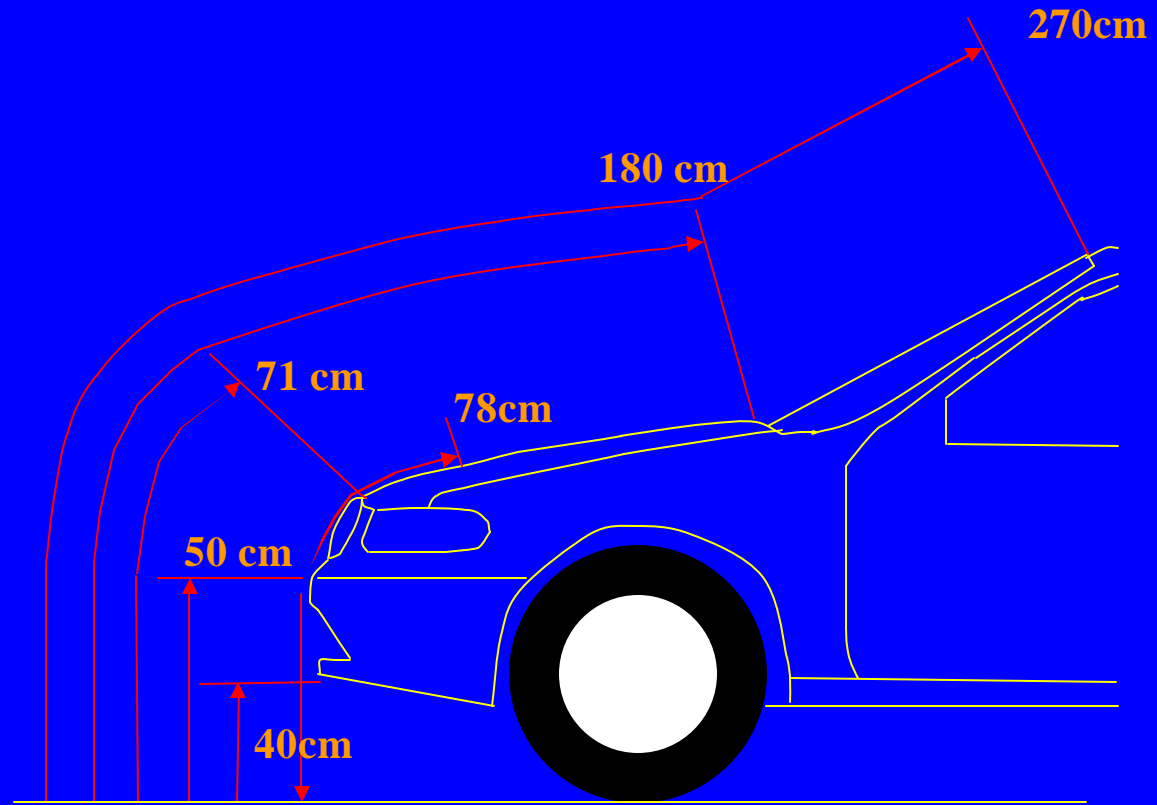
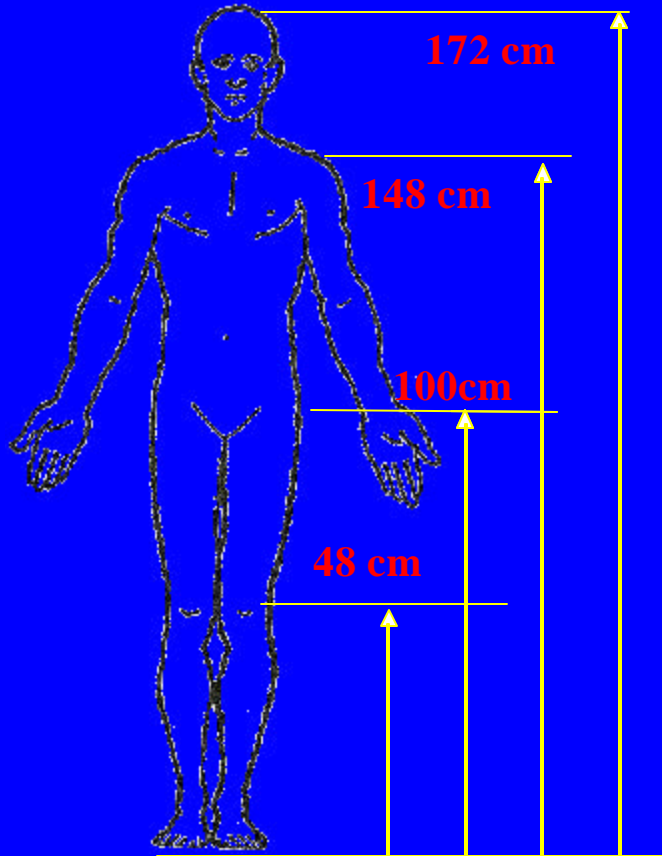


Case #2

- Male age 35 attempting to cross a 7-lane roadway at 19:00. Clear & dry conditions, on a Sunday evening in the winter.
- Driver of 1997 Honda Accord did not observe pedestrian until impact.
- Pedestrian was struck on his right side



Pedestrian Wrap Measurements



Vehicle 1



Honda Inova Fairfax Hospital CIREN Center

Case Summary:

- On Scene: pedestrian found conscious and alert, deformities to the left arm & right lower extremity as well as laceration to the left scalp
- Immobilized and transported to the Trauma Center by air
- Physical examination notable for:
 - left temporal scalp laceration, swelling of right shoulder, deformed right lower extremity, positive for alcohol consumption
- Radiological examination identified:
 - right comminuted tibia and fibula fractures
 - right comminuted proximal humerus fracture
 - CT scan of head negative for intracranial injury
- Right lower extremity splinted, right arm placed in sling
- Admitted to IMC
- To the OR on HD # 2 for:
 - four-compartment fasciotomy
 - external fixator to the right lower extremity



Case Summary (continued):

- Remained stable, transfer to the ward on HD # 3
- Returned to the OR on HD # 4 for:
 - ORIF of the right proximal humerus fracture
 - debridement and irrigation of the right lower extremity
- Returned to the OR on HD # 10 for:
 - removal of external fixator
 - plating of the right fibula with wound closure
- PM&R evaluation diagnosed cerebral concussion - RLAS of VII
- Discharged home with home health services on HD # 15
- Hospital Charges: \$78,965



Injuries (ICD)	AIS Severity	Info Source	Aspect (R,L,bilat,etc)	Contact Area (door, seat,etc)
Cerebral concussion (850.0)	161000.2	Exam	Whole	Windshield
Scalp laceration (873.0)	190602.1	Exam	Left	Windshield



Injuries (ICD)	AIS Severity	Info Source	Aspect (R,L,bilat,etc)	Contact Area (door, seat,etc)
Humerus fracture (812.0)	752604.3	X-ray	Right	Cowl/base of windshield



Injuries (ICD)	AIS Severity	Info Source	Aspect (R,L,bilat,etc)	Contact Area (door, seat,etc)
Thigh abrasion (916.0)	890202.1	Exam	Right	Leading edge of hood
Tibia fracture Fibula fracture (823.2)	853422.3 851606.2	X-ray	Right	Bumper
Heel contusion (928.20)	890402.1	Exam	Right	Unknown



Examples of Lessons Learned

1. Head Injuries

- Comparison of PCDS and CIREN data
- Risk of head injury significantly decreases when the head strikes the center of the windshield
- Risk of head injury ($AIS \geq 2$) is two (2) times more likely when the head strikes around the edge of the windshield

2. Humerus Fractures

- Comparison of PCDS and CIREN data could not be done for humerus fractures based on selection criteria
- CIREN pedestrians are at an increased risk for humerus fractures; 23% of CIREN pedestrian cases involve a humerus fracture compared with 7% of PCDS cases



Conclusion

We would like to thank the following agencies for making this project a success:

Honda R&D Co. Ltd

The Fairfax County Police Crash Reconstruction Unit

Fairfax County EMS

Prince William County EMS

