Use of Age, Height and Weight to Predict Injury in Pediatric Advanced Automatic Crash Notification

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What is Advanced Automatic Crash Notification?

- **Automatic Crash Notification (ACN):** Technology that automatically alerts response centers when a motor vehicle crash (MVC) has taken place.

- **Advanced Automatic Crash Notification (AACN):** Technology that uses vehicle telemetry data from Event Data Recorder (EDR) to predict risk of serious injury among occupants.
A child’s developmental stage affects the injuries incurred.

Thus, a pediatric AACN algorithm should have some quantification of developmental stage to help determine injury risk.

Goal of this project was to determine best metric of development to use in a pediatric AACN (age, height or weight).
Methods

National Automotive Sampling System 2000-2011
- Maintained by NHTSA
- Provides representative sample of all crashes in the US

Evaluation of Occupants

✓ Age, height & weight evaluated & occupants with impossible/missing values removed

✓ Occupants classified as optimally, sub-optimally or unrestrained

✓ Occupants classified as obese, overweight, normal weight or underweight
Methods (Cont)

Evaluation of Crash

✓ Crash mode classified as rollover, frontal, rear, near-side or far-side

✓ Change in speed of vehicle at time of crash (delta V) recorded

Evaluation of Injuries

✓ Anatomic Patterns of Injuries
  • Body regions affected

✓ “Mechanistic” Patterns of Injuries
  • Presence/Absence of Fracture
  • Hemorrhagic Component
  • AIS Severity (2+ vs 3+)
Anatomic Patterns by Age

Percent of Injuries Involving Specific Body Region by Age

Increasing Age
(0yr) → (18yr)
Methods: Logistic Regression

- Occupant assigned dichotomous “Y/N” outcomes for each injury type

- **Logistic regression** employed to determine odds of each injury type given change in age, height or weight while controlling for cofounders (crash type, delta V, restraint/car seat use & gender)
Head Injuries

Adjusted Odds of Injury per Given Increase in Age, Height or Weight

- **Age (per 1 year increase)**
- **Height (per 5cm Increase)**
- **Weight (per 5kg increase)**

- **AIS 2+ Head Injury**
- **Hemorrhagic Brain Injury**
- **Skull Fracture**
- **AIS 3+ Head Injury**
Thoracic Injuries

- AIS 2+ Thoracic Injuries
- Thoracic Wall Fractures
- Internal Thoracic Injuries
- AIS 3+ Thoracic Injuries

Adjusted Odds Ratios
- Age (per 1 year increase)
- Height (per 5 cm increase)
- Weight (per 5 kg increase)
Abdominal Injuries

- Age (per 1 year increase)
- Height (per 5cm increase)
- Weight (per 5kg increase)

Adjusted Odds of Injury per Given Increase in Age, Height or Weight

Adjusted Odds Ratios

0.99 1.00 1.01 1.02 1.03 1.04 1.05

AIS 2+ Abdominal Injuries

Hemorrhagic Abdominal Injuries

AIS 3+ Abdominal Injuries
Spine Injuries

Adjusted Odds of Injury per Given Increase in Age, Height or Weight

Adjusted Odds Ratios

- Age (per 1 year increase)
- Height (per 5cm increase)
- Weight (per 5kg increase)

AIS 2+ Spine Injuries
Spinal Fractures
AIS 3+ Spine Injuries
Extremity Injuries

- Age (per 1 year increase)
- Height (per 5cm increase)
- Weight (per 5kg increase)

Adjusted Odds of Injury per Given Increase in Age, Height or Weight

Adjusted Odds Ratios

AIS 2+ Upper Extremity Injury

AIS 2+ Lower Extremity Injury
The BMI Effect

- Age (BMI not controlled)
- Age (BMI controlled)

Adjusted Odds Ratio of Injury per Given Increase in Age, Height or Weight
Age, Height or Weight?

 ✓ Weight was not a significant predictor of injury in many of the models.

 ✓ Height would be nearly impossible to keep track of by a vehicle for use in an AACN algorithm.

 ✓ Age was a significant predictor of all injury types, even after controlling for BMI.

 ✓ Age can be programmed into vehicle’s AACN software via birthdate.

 ✓ Age is likely to be the best predictor for our purposes.
Thank you!

Questions?
Back Up Slides
Scope of the Problem

• Unintentional injury is the leading cause of death in children aged 1-19 years in the US

• In 2012, Motor Vehicle Crashes (MVCs) accounted for the majority of these fatalities
Trauma Triage

- **Trauma Triage**: Process of determining which patient needs the most urgent treatment and where (TC vs Non-TC)

- **“Golden Hour” of Trauma**
  - Want to make triage decisions as quickly as possible
  - Need best information to make best decisions
Flow of Events after MVC = Process of Trauma Triage

Traditional 9-1-1 Flowchart

Event Occurs → 9-1-1 Call → PSAP/EMD → Response → Scene Care → Transfer of Care → Treatment
How can we speed and decrease risk of error after MVC?

Advanced Automatic Crash Notifications Impact on a 9-1-1 Event

Event Occurs 9-1-1 Call PSAP/EMD Response

AACN Information

Transfer-Continuum Treatment Scene Care
Determining the Most Frequent Injuries

2000-2011
Excluded 2009-2011 with MY > 10 yrs (injury data missing)

Inclusion Criteria
- Age < 19yo
- AIS 2+ Injuries

95%: 195 Unique Injuries
100%: 551 Unique Injuries
Descriptive Statistics

After exclusions, **11,541 occupants** for evaluation

- **Mean Age**: 12.6 yrs +/- 5.6 yr
- **Gender**: 48% female
- **BMI Category**
  - 5% Underweight
  - 58% normal weight
  - 14% overweight
  - 21% obese
- **Restraint Status**
  - 25% unrestrained,
  - 54% optimally restrained
  - 20% sub-optimally restrained

- **Impacts**
  - 52% frontal impacts
  - 21% rollover
  - 10% far-side
  - 9% near-side
  - 6% rear