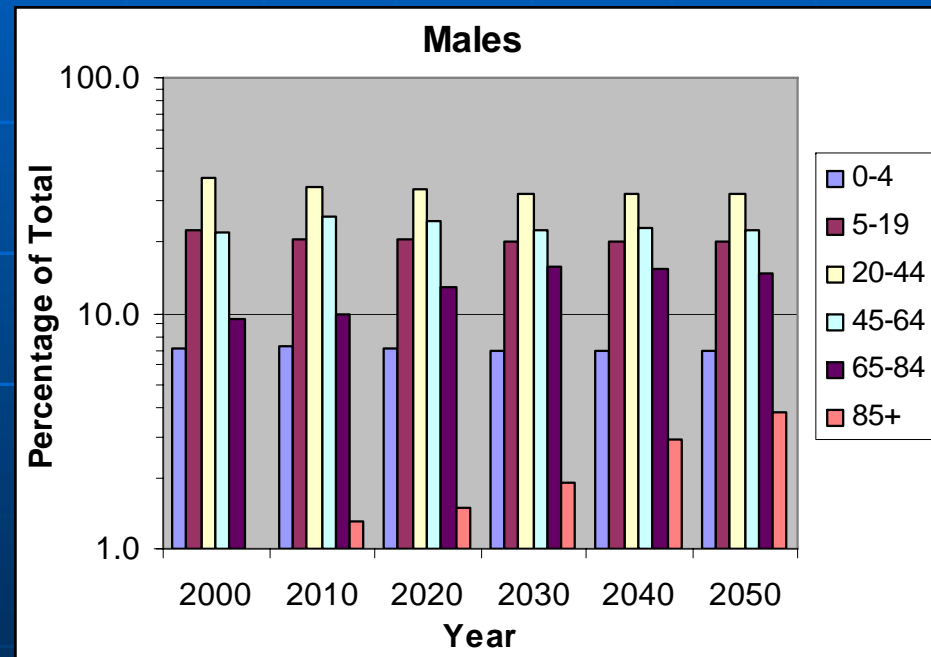
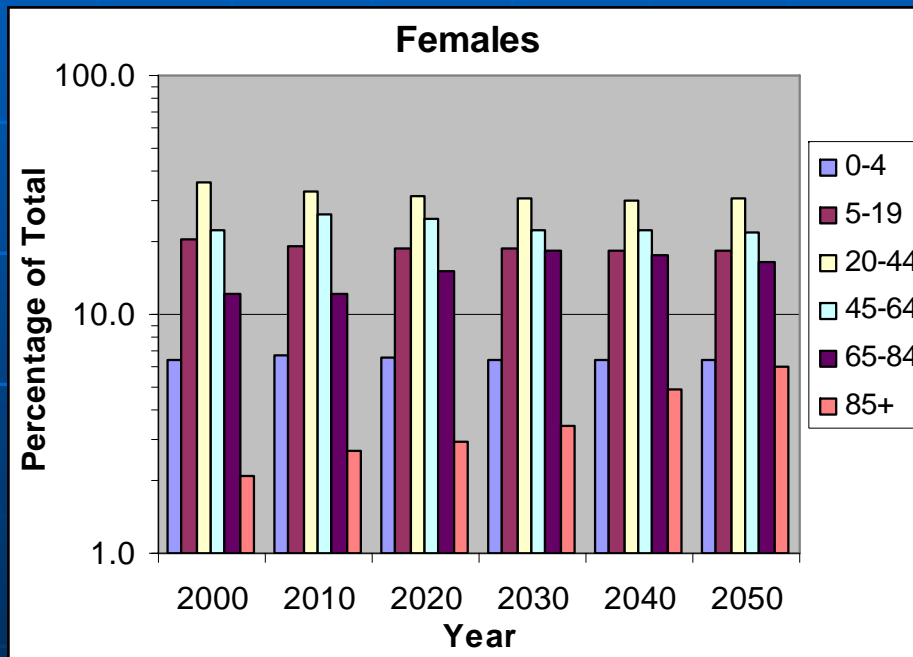


What Constitutes an Elderly
Motor Vehicle Crash Victim –
The Age Threshold At Which Specific
Injuries Increase The Risk Of
Mortality.

The Toyota -Wake Forest University
School of Medicine
CIREN Team

The Elderly Population In America

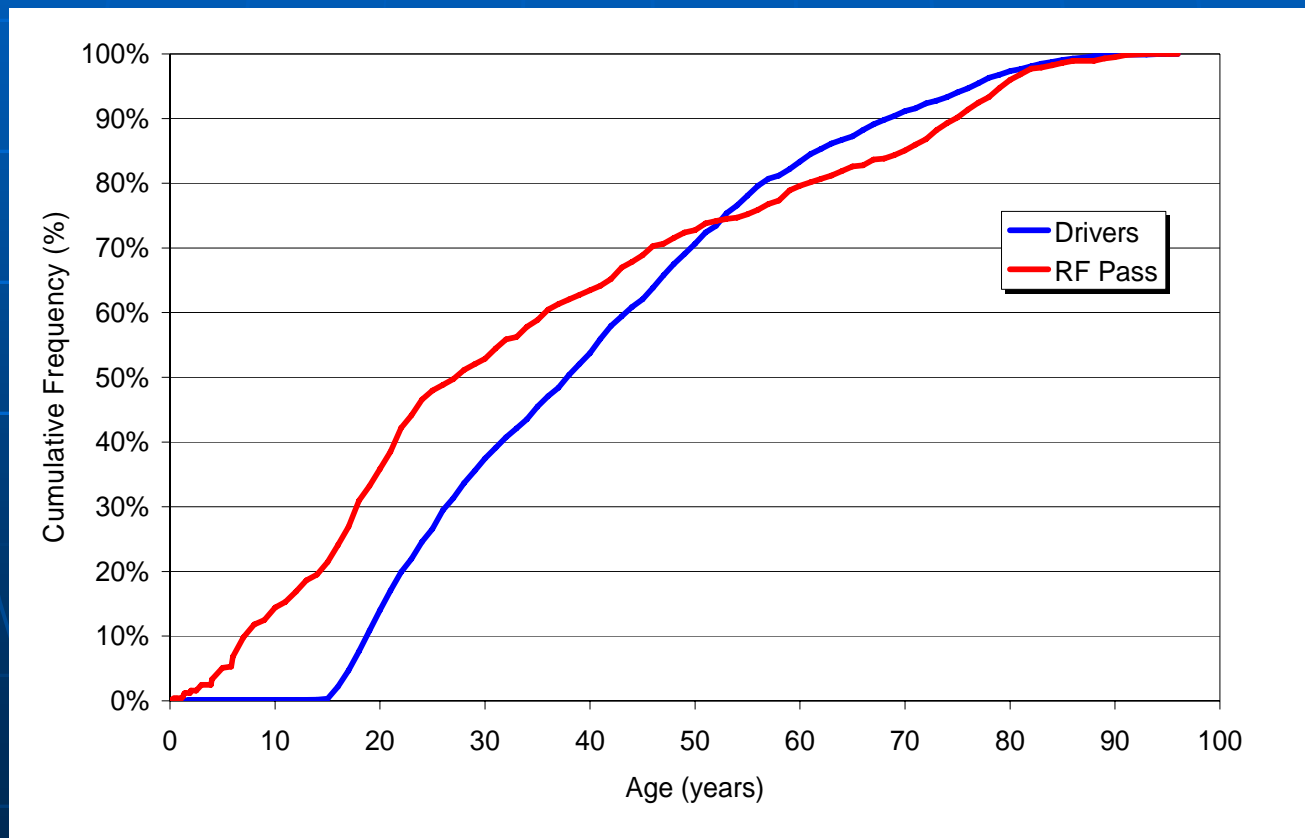
1. Distribution of US Elderly Population
2. Distribution of Elderly Drivers



Source: US Census, 2000-2050

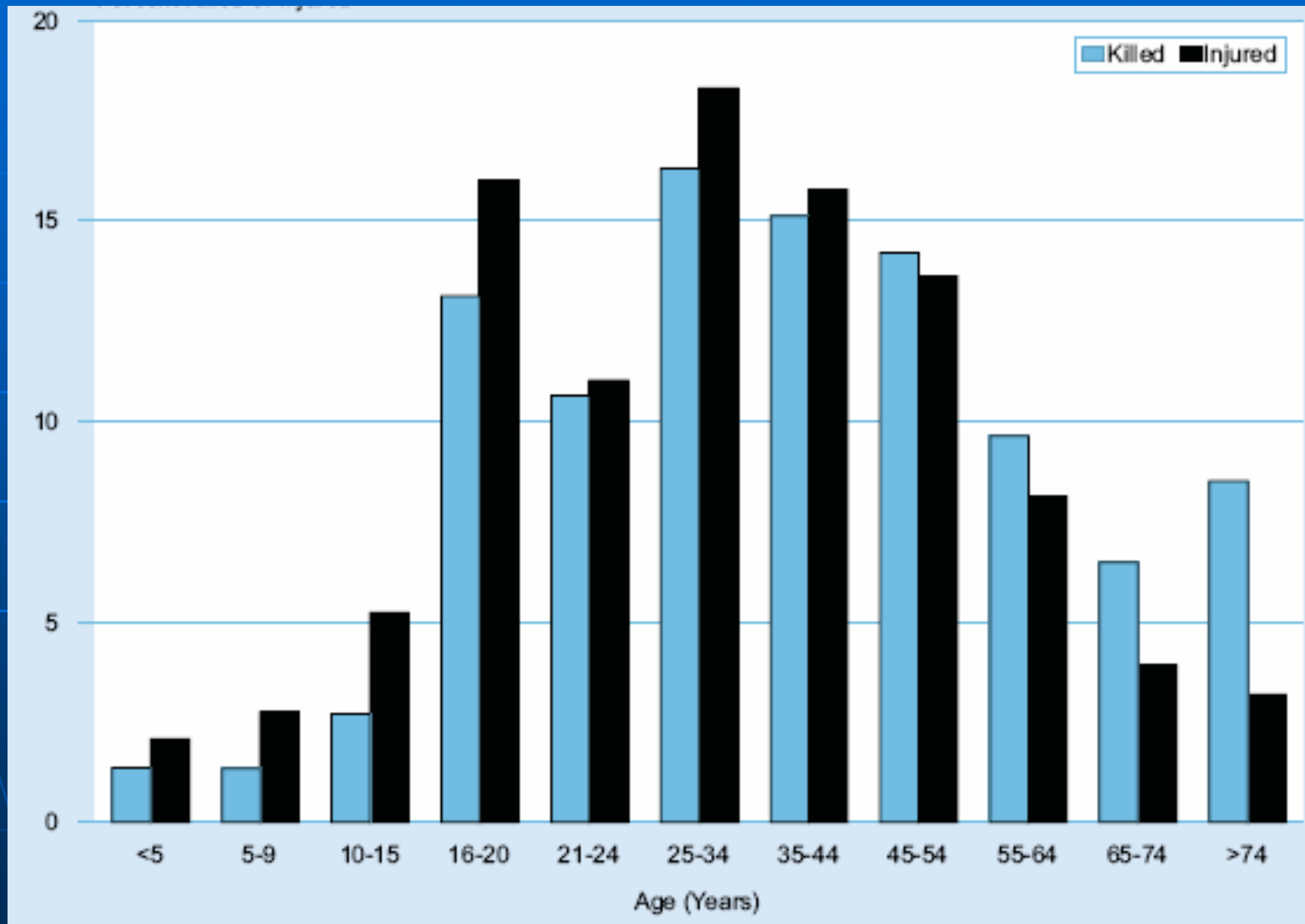
The Elderly Population In America

1. Distribution of US Elderly Population
2. Distribution of Elderly Drivers



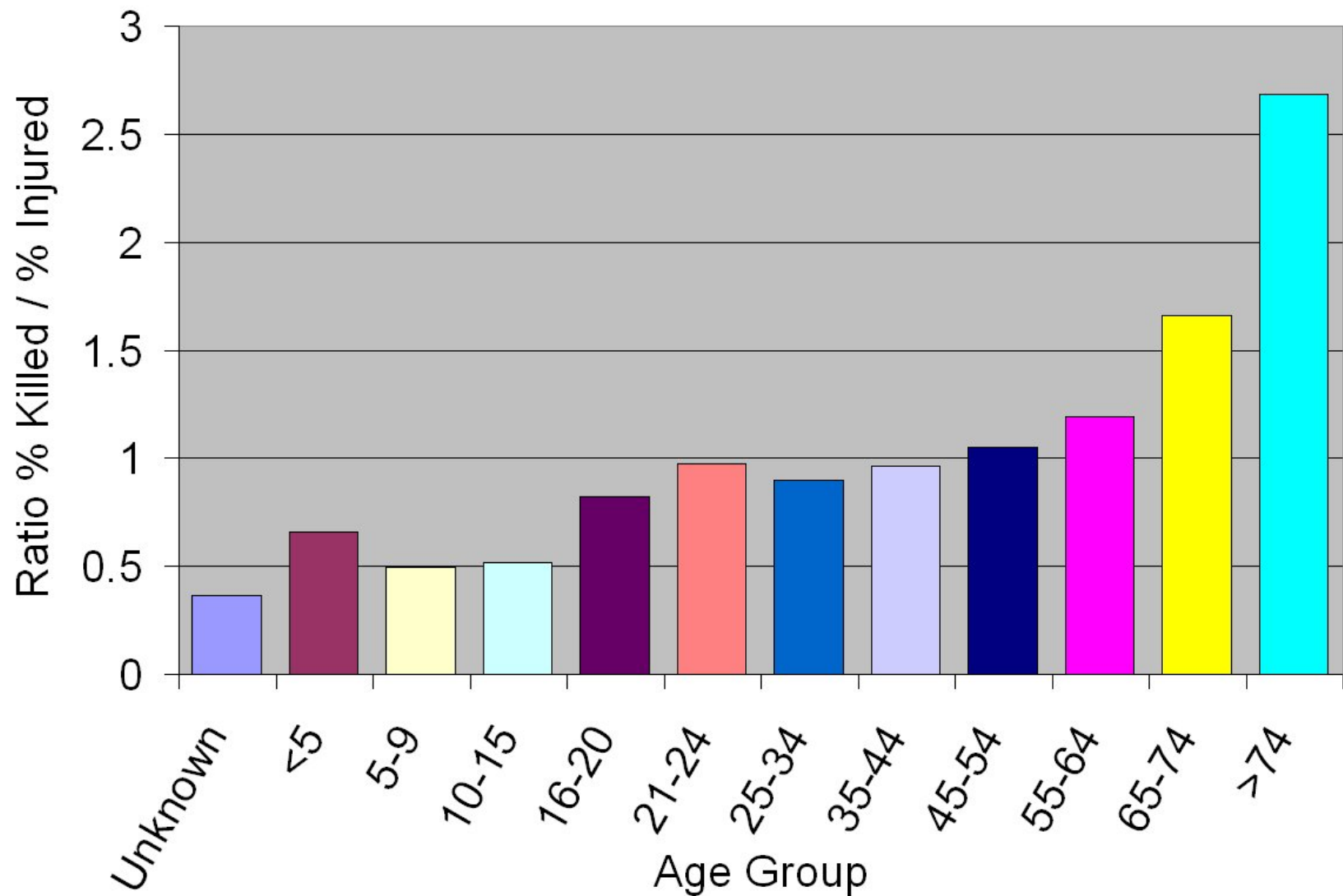
Source: CIREN, February 2007

Percent of Persons Killed or Injured by Age



Source: NHTSA: *Traffic Safety Facts, 2005*

A better way to look at it...



Challenges For Policy Makers

- Record Numbers of Elderly Drivers
- Very Little Legislation
- Additional Challenges

Elderly Trauma Victims

- People over 55 Constitute 15% of MVC trauma victims
- The Mortality Rate for this group is 2.54% (1.39% for everyone else)
- What are the reasons for this and other characteristics of the aged?

Age As A Risk Factor

- Patient Age has utility in risk prediction and adjustment models
- Usually Age is used as a surrogate for pre-existing comorbidities (PEC)
- At least two problems:
 - PEC effect can be better estimated
 - Age and PEC technically measure different (though related) quantities

Age As A Risk Factor

- Most risk adjustment approaches model age as a dichotomous variable
- Age 55 is the commonly accepted threshold (based solely on clinical acumen)
- Adjusted Odds Ratios for Age Threshold
 - Original TRISS score – 5.71
 - Our own NTDB score – 6.36

Problems With Global Age Threshold Approach

- The global estimate (55) at best over-generalizes the age contribution
- Certainly immunity from death will depend BOTH on age and the *specific* set of injuries of the patient.

Study Objectives

- For specific injuries common to elderly car crash victims:
 - Ascertain whether age is an important determinant of survival
 - Identify the age at which this injury becomes a major threat to survival

Study Methods – CIREN Database

- The CIREN database was interrogated for the top 10 most frequently occurring injuries in persons over age 45

- AIS Body Regions
 - 1 – Head
 - 2 – Face
 - 3 – Neck
 - 4 – Thorax
 - 5 – Abdomen
 - 6 – Spine
 - 7 – Upper Extremities
 - 8 – Lower Extremities
 - 9 – Unspecified

National Trauma Data Bank (NTDB)

- Sponsored by the American College of Surgeons (ACS)
- 1.5 million trauma cases from 904 hospitals in every state
- More than 200 ACS-verified trauma centers

National Trauma Data Bank (NTDB)

- 35% of patients treated were injured in motor vehicle crashes (MVC)
- Data collected:
 - Pre-hospital demographics
 - Injury Variables
 - Outcomes Data
- Data not collected:
 - Crash characteristics

NTDB Case Selection

- For a specific Injury I , all NTDB cases meeting the following criteria
 - ECODE range 810.0 to 825.9
 - Age > 25 years old
 - Among the top 10 injuries per body region subset from the CIREN database

For Each Injury / ...

- A study dataset containing only patients with this injury is constructed
- Also collected are known covariates (other factors associated with death)
- Primary Variable of Interest is AGE

Covariates

- Injury Severity Score
- ED GCS MOTOR
- ED GCS VERBAL
- ED GCS EYE
- Payor Status (1=uninsured, 0=insured)
- Race
- Gender
- Year of Injury
- MAX AIS in each body region

For Each Injury / ...

- A Multiple Logistic Regression (MLR) model was constructed to relate death as a function of age controlling for the covariates
- The impact of age in terms of statistical significance was determined
- Adjusted odds ratios (OR) for death are calculated for continuous age

Missing Data

- Missing data are present in some of the covariates
- Multiple Imputation (MI) methods were used to maximize the amount of data considered via MCMC iterations
- Goals of MI:
 - Impute values that will maintain the covariance structure of the regression
 - Maximize the information used
 - Goal is NOT to “replace the data with a plausible” value

Area Under ROC Curve (AUROC)

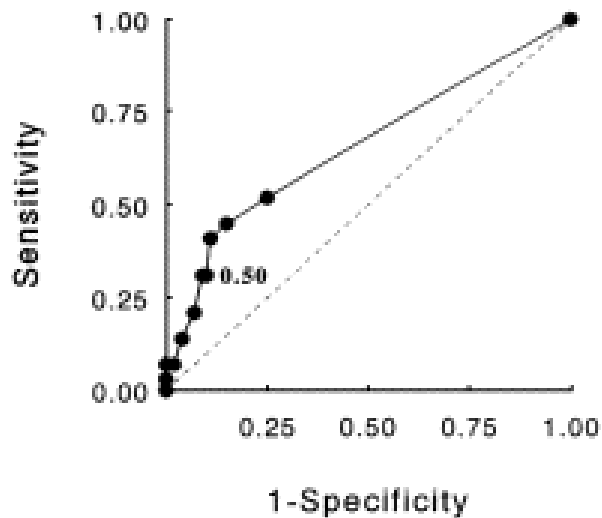
- Measures discrimination – the model's ability to distinguish between survivors and non-survivors at each specific age threshold
- Sliding scale of sensitivity and specificity
- Bounded by 0.5 and 1.0
 - Values closer to 0.5 indicate poor discrimination
 - Values closer to 1.0 indicate excellent survival
- ie goal is to find threshold with highest area under the curve.

Adjusted AUROC

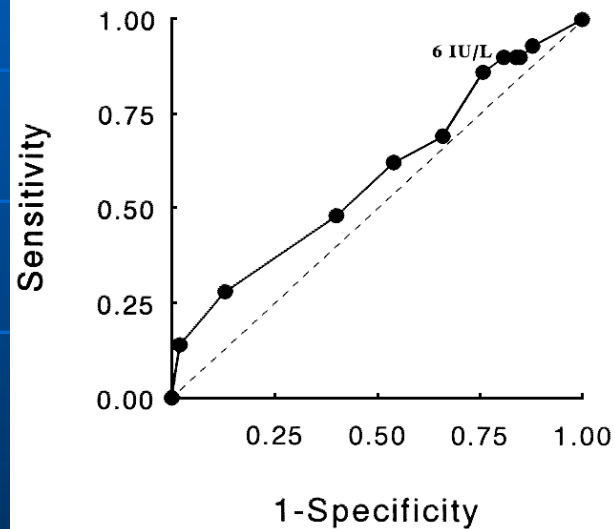
- Take a randomly paired survivor and non-survivor – the probability that the survivor will have a higher predicted survival than the non-survivor
- The MLR (regression) model produces adjusted estimates of mortality risk

BCI ROC Curves

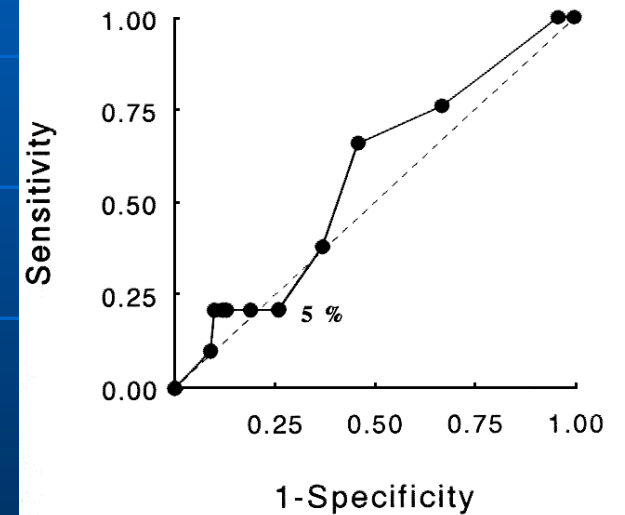
Troponin T



CKMB



CKMB/CK



ROC Curve Analysis

- Iterative Algorithm
 - Define a binary threshold for age (starting with 25)
 - Use this term in the adjusted model instead of age
 - Record the AUROC

ROC Curve Analysis, cont.

- Shift the threshold for age up one unit (from 30 to 31)
- Use this new threshold in the adjusted model
- Record the AUROC for the new threshold
- Keep repeating until all binary ages have been cycled through.
- Record the age whose binary threshold produced the largest AUROC

Results – Top Head Injuries

Body Region 1 -- Head		
140684.3	CEREBRUM, SUBARACHNOID HEMORRHAGE	13282
140652.4	CEREBRUM, HEMATOMA, SUBDURAL, SMALL (< 50CC ADULT; < 25CC IF < 10 YEARS OLD; < 1CM THICK; SMEAR; TINY; MODERATE	3331
140606.3	CEREBRUM, CONTUSION, SINGLE, SMALL (SUPERFICIAL; < 30CC; < 4CM DIAMETER; MIDLINE SHIFT < 5MM)	1602
140678.4	CEREBRUM, INTRAVENTRICULAR HEMORRHAGE	1888
160204.3	UNCONSCIOUSNESS < 1HR. WITH NEUROLOGICAL DEFICIT	188
150206.4	BASE (BASILAR) FRACTURE COMPLEX (OPEN WITH LOSS OF BRAIN TISSUE, COMMINUTED; RING; HINGE)	788
150200.3	BASE (BASILAR) FRACTURE NFS (MAY INVOLVE ETHMOID, ORBITAL ROOF, SPHENOID, TEMPORAL INCLUDING PETROUS, SQUAMOUS OR MASTOID PORTIONS OR OCCIPITAL BONES)	5818
150202.3	BASE (BASILAR) FRACTURE WITHOUT CSF LEAK	1578
140466.3	CEREBELLUM INJURY INVOLVING ANY OF THE FOLLOWING BUT NOT FURTHER SPECIFIED ANATOMICALLY OTHER THAN CEREBELLUM, INFRATENTORIAL OR POSTERIOR FOSSA: SUBARACHNOID HEMORRHAGE	529
140628.5	CEREBRUM, DIFFUSE AXONAL INJURY (WHITE MATTER SHEARING)	1531

Results – Top Face Injuries

Body Region 2 -- Face		
251204.3	ORBIT, FRACTURE, OPEN/DISPLACED/COMMINUTED	1764
250808.3	MAXILLA, FRACTURE, LE FORT III	607
250810.4	MAXILLA FRACTURE, LE FORT III, BLOOD LOSS > 20% BY VOLUME	63

Results - Top Neck Injuries

Body Region 3 -- Neck		
321018.3	VERTEBRAL ARTERY, THROMBOSIS (OCCLUSION) SECONDARY TO TRAUMA	99
321010.3	VERTEBRAL ARTERY, LACERATION (PERFORATION, PUNCTURE), MINOR, WITH NEUROLOGICAL DEFICIT (STROKE)	2
321012.3	VERTEBRAL ARTERY, LACERATION (PERFORATION, PUNCTURE), MAJOR	21

Results - Top Thorax Injuries

Body Region 4 -- Thorax		
450232.4	RIB CAGE, FRACTURE, > 3 RIBS ON ONE SIDE AND <= 3 RIBS ON OTHER SIDE, STABLE CHEST OR NFS, WITH HEMO/PNEUMO THORAX	4930
441406.3	LUNG, CONTUSION, UNILATERAL	10411
450230.3	RIB CAGE, FRACTURE, > 3 RIBS ON ONE SIDE AND <= 3 RIBS ON OTHER SIDE, STABLE CHEST OR NFS	5213
450222.3	RIB CAGE, FRACTURE, 2-3 RIBS ANY LOCATION OR MULTIPLE FRACTURES OF SINGLE RIB, WITH STABLE CHEST OR NFS WITH HEMO/PNEUMOTHORAX	6339
450242.5	RIB CAGE, FRACTURE, > 3 RIBS ON EACH OF TWO SIDES, WITH STABLE CHEST OR NFS, WITH HEMO/PNEUMO THORAX	1028
442202.3	THORACIC CAVITY INJURY NFS WITH HEMO/PNEUMOTHORAX	12313
441410.4	LUNG, CONTUSION, BILATERAL	6047
450266.5	RIB CAGE, FRACTURE, FLAIL (UNSTABLE CHEST WALL), BILATERAL	506
450214.3	RIB CAGE, FRACTURE, 1 RIB, WITH HEMO/PNEUMOTHORAX	2772
450264.4	RIB CAGE, FRACTURE, FLAIL CHEST (UNSTABLE CHEST WALL), WITH LUNG CONTUSION	1513

Results - Top Abdomen Injuries

Body Region 5 -- Abdomen		
544224.3	SPLEEN, LACERATION, MODERATE (NO HILAR OR SEGMENTAL PARENCHYMAL DISRUPTION OR DESTRUCTION; > 3CM DEEP; WITH MAJOR VESSEL INVOLVEMENT)	2105
541824.3	LIVER, LACERATION, MODERATE (> 3CM DEEP, WITH MAJOR DUCT INVOLVEMENT; BLOOD LOSS > 20% BY VOLUME)	1852
544226.4	SPLEEN, LACERATION, MAJOR (INVOLVING SEGMENTAL PARENCHYMAL DISRUPTION OR DESTRUCTION WITH NO HILAR INJURY)	1459
543800.3	RETROPERITONEUM HEMORRHAGE OR HEMATOMA	2158
541826.4	LIVER, LACERATION, MAJOR (DISRUPTION OF < 50% OF HEPATIC PARENCHYMA; MULTIPLE LACERATION > 3CM DEEP; BURST INJURY)	1048
541828.5	LIVER, LACERATION, MASSIVE, COMPLEX (DISRUPTION OF > 50% OF CENTRAL HEPATIC VASCULAR SYSTEM AND INVOLVING RETROHEPATIC VENA CAVA/ HEPATIC VEIN/HEPATIC ARTERY/PORTAL VEIN/MAJOR DUCT)	341
544228.5	SPLEEN, LACERATION, MASSIVE (WITH HILAR DISRUPTION; TISSUE LOSS; AVULSION; STELLATE)	866
541424.3	JEJUNUM-ILEUM, LACERATION, PERFORATION (FULL THICKNESS BUT NOT COMPLETE TRANSECTION)	457
541624.3	KIDNEY, LACERATION, MODERATE (> 1CM BUT NO CORTEX INVOLVEMENT OR URINARY EXTRAVASATION)	361
520606.3	ILIAC ARTERY (COMMON, INTERNAL, EXTERNAL), LACERATION (PERFORATION, PUNCTURE), MINOR	43

Results - Top Spine Injuries

Body Region 6 – Spine		
650224.3	CERVICAL SPINE, DISC, FRACTURE WITHOUT CORD CONTUSION OR LACERATION WITH OR WITHOUT DISLOCATION, LAMINA	2603
650222.3	CERVICAL SPINE, FRACTURE WITHOUT CORD CONTUSION OR LACERATION WITH OR WITHOUT DISLOCATION, FACET	2864
650228.3	CERVICAL SPINE, DISC, FRACTURE WITHOUT CORD CONTUSION OR LACERATION WITH OR WITHOUT DISLOCATION, ODONOTOID (DENS)	1416
650226.3	CERVICAL SPINE, DISC, FRACTURE WITHOUT CORD CONTUSION OR LACERATION WITH OR WITHOUT DISLOCATION, PEDICLE	1102
650634.3	LUMBAR SPINE, FRACTURE WITHOUT CORD CONTUSION OR LACERATION WITH OR WITHOUT DISLOCATION, VERTEBRAL BODY, MAJOR COMPRESSION (>20% LOSS OF HEIGHT)	877
650434.3	THORACIC SPINE, FRACTURE WITHOUT CORD CONTUSION OR LACERATION WITH OR WITHOUT DISLOCATION, VERTEBRAL BODY, COMPRESSION (>20% LOSS OF HEIGHT)	810
640204.3	CERVICAL SPINE, CORD CONTUSION, WITH TRANSIENT NEUROLOGICAL SIGNS, WITH FRACTURE	394
650234.3	CERVICAL SPINE, DISC, FRACTURE WITHOUT CORD CONTUSION OR LACERATION WITH OR WITHOUT DISLOCATION, VERTEBRAL BODY, MAJOR COMPRESSION (>20% OF HEIGHT)	203
650424.3	THORACIC SPINE, FRACTURE WITHOUT CORD CONTUSION OR LACERATION WITH OR WITHOUT DISLOCATION, LAMINA	422
650422.3	THORACIC SPINE, FRACTURE WITHOUT CORD CONTUSION OR LACERATION WITH OR WITHOUT DISLOCATION, FACET	245

Results - Top Upper Extremity Injuries

Body Region 7 – Upper Extremities		
752804.3	RADIUS FRACTURE, OPEN/DISPLACED/COMMINUTED	5492
753204.3	ULNA FRACTURE, OPEN/DISPLACED/COMMINUTED	4494
752604.3	HUMERUS FRACTURE, OPEN/DISPLACED/COMMINUTED	4004
752806.3	RADIUS FRACTURE, WITH RADIAL NERVE INVOLVEMENT	56
753206.3	ULNA FRACTURE WITH ULNAR NERVE INVOLVEMENT	63
711000.3	AMPUTATION (TRAUMATIC) AT ANY POINT OF EXTREMITY EXCEPT FINGER	225
721206.3	OTHER NAMED VEINS, LACERATION, MAJOR	9
752606.3	HUMERUS FRACTURE, WITH RADIAL NERVE INVOLVEMENT	147
792010.3	UPPER EXTREMITY 3RD DEGREE BURN <10% TBS W/ FACE/HAND/GENITALIA INVOLVEMENT	0
794006.3	DEGLOVING INJURY HAND, PALM OR ENTIRE EXTREMITY	0

Results - Top Lower Extremity Injuries

852604.3	PELVIS, FRACTURE, WITH OR WITHOUT DISLOCATION, OPEN/DISPLACED/COMMINUTED	5787
851814.3	FEMUR, FRACTURE, SHAFT	6604
853422.3	TIBIA, SHAFT, OPEN/DISPLACED/COMMINUTED	4802
851822.3	FEMUR, FRACTURE, SUPRACONDYLAR	1412
851614.3	FIBULA, FRACTURE, BIMALLEOLAR OR TRIMALLEOLAR, OPEN/DISPLACED/COMMINUTED	984
852800.3	SACROILIUM FRACTURE WITH OR WITHOUT DISLOCATION	3406
853408.3	TIBIA, FRACTURE, CONDYLES (PLATEAU), OPEN/DISPLACED/COMMINUTED	3207
851810.3	FEMUR, FRACTURE, INTERTROCHANTERIC	2251
853000.3	SYMPHYSIS PUBIS SEPARATION (FRACTURE)	3976
851812.3	FEMUR, FRACTURE, NECK	2094

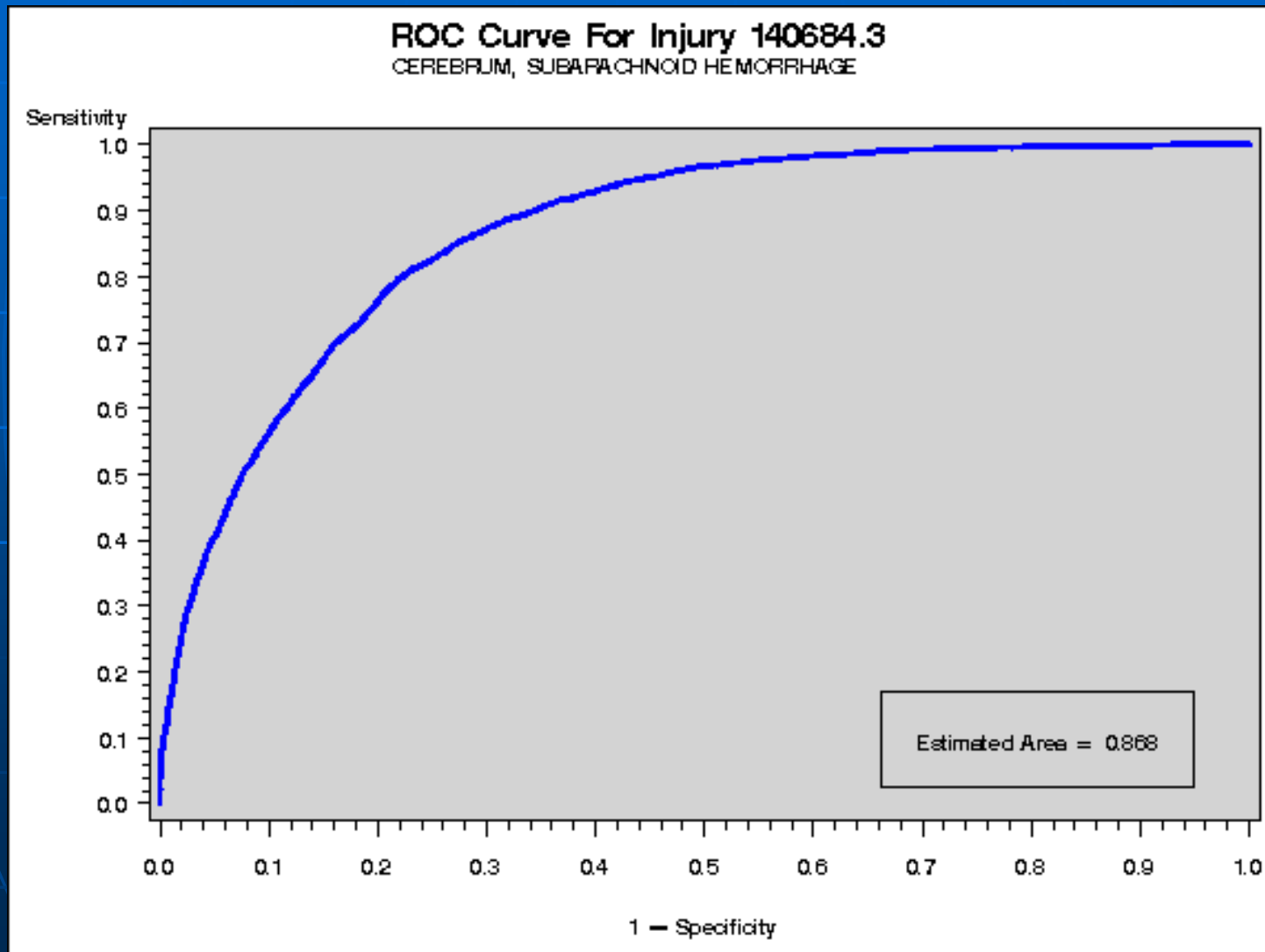
EXAMPLE: AIS 140684.3 - CEREBRUM, SUBARACHNOID HEMORRHAGE

- 13,282 patients in NTDB with 140684.3
- Mortality – 22.7%
- Males 64.3%
- Mean ISS = 24.2

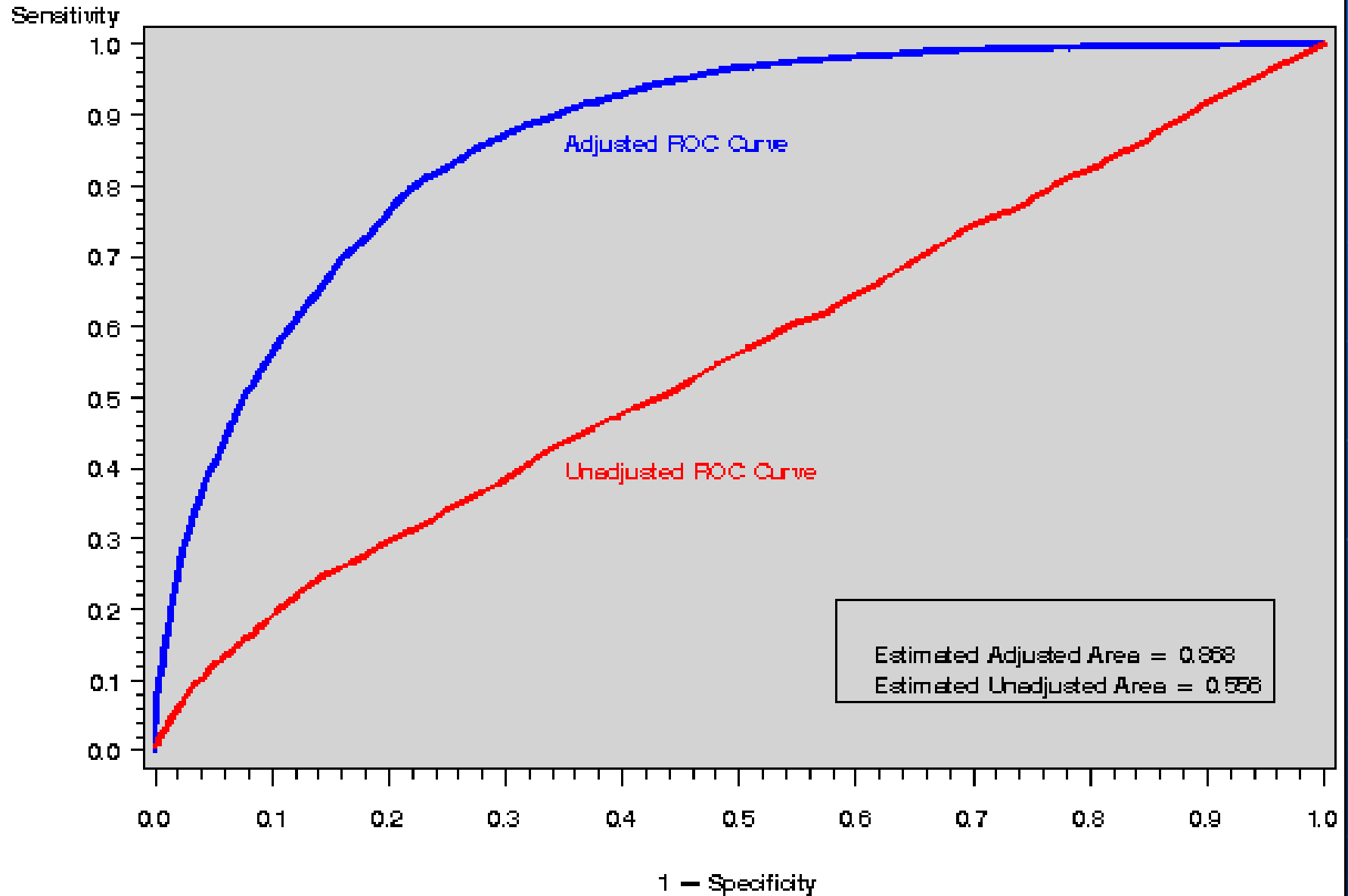
AIS 140684.3 – Significant Terms in Model

AISCODE	VARIABLE	ESTIMATE	STDERR	LOWER CI	UPPER CI	T-STAT	P
140684.3	ISS	0.064866	0.002271	0.0604	0.0693	28.57	<.0001
	EDVERBAL	-0.257101	0.039295	-0.3341	-0.1801	-6.54	<.0001
	EDMOTOR	-0.298565	0.026104	-0.3499	-0.2472	-11.44	<.0001
	SES	0.695411	0.077544	0.5408	0.8500	8.97	<.0001
	AGE	0.041023	0.001772	0.0375	0.0445	23.16	<.0001
	YOINJ	-0.151561	0.018715	-0.1882	-0.1149	-8.10	<.0001

Age That Maximizes This Curve – 40 Years Old



Comparison of Adjusted and Unadjusted ROC Curves For Injury 140684.3 CEREBRUM, SUBARACHNOID HEMORRHAGE



Head Injury Thresholds

AISCODE	Injury Description	Age Cut Off	ROC	OR		
140684.3	CEREBRUM, SUBARACHNOID HEMORRHAGE	40	0.869	1.055	1.050	1.060
140652.4	CEREBRUM, HEMATOMA, SUBDURAL, SMALL (< 50CC ADULT; < 25CC IF < 10 YEARS OLD; < 1CM THICK; SMEAR; TINY; MODERATE	67	0.874	1.032	1.020	1.044
140606.3	CEREBRUM, CONTUSION, SINGLE, SMALL (SUPERFICIAL; < 30CC; < 4CM DIAMETER; MIDLINE SHIFT < 5MM)	83	0.898	1.042	1.026	1.059
140678.4	CEREBRUM, INTRAVENTRICULAR HEMORRHAGE	68	0.794	1.029	1.018	1.041
160204.3	UNCONSCIOUSNESS < 1HR. WITH NEUROLOGICAL DEFICIT	62	0.923	1.015	0.954	1.081
150206.4	BASE (BASILAR) FRACTURE COMPLEX (OPEN WITH LOSS OF BRAIN TISSUE, COMMUNUTED; RING; HINGE)	65	0.896	1.013	0.993	1.033
150200.3	BASE (BASILAR) FRACTURE NFS (MAY INVOLVE ETHMOID, ORBITAL ROOF, SPHENOID, TEMPORAL INCLUDING PETROUS, SQUAMOUS OR MASTOID PORTIONS OR OCCIPITAL BONES)	40	0.899	1.054	1.044	1.064
150202.3	BASE (BASILAR) FRACTURE WITHOUT CSF LEAK	59	0.903	1.038	1.017	1.058
140466.3	CEREBELLUM INJURY INVOLVING ANY OF THE FOLLOWING BUT NOT FURTHER SPECIFIED ANATOMICALLY OTHER THAN CEREBELLUM, INFRATENTORIAL OR POSTERIOR FOSSA: SUBARACHNOID HEMORRHAGE	62	0.916	1.055	1.028	1.084
140628.5	CEREBRUM, DIFFUSE AXONAL INJURY (WHITE MATTER SHEARING)	53	0.755	1.011	0.995	1.027

Face Injury Thresholds

Body Region 2 -- Face						
AIS Code	Injury Description	Age Cut Off	ROC	OR		
251204.3	ORBIT, FRACTURE, OPEN/DISPLACED/COMMINUTED	60	0.920	1.016	0.995	1.038
250808.3	MAXILLA, FRACTURE, LE FORT III	62	0.888	1.063	1.030	1.096
250810.4	MAXILLA FRACTURE, LE FORT III, BLOOD LOSS > 20% BY VOLUME	49	0.914	1.013	0.923	1.112

Thorax Injury Thresholds

450232.4	RIB CAGE, FRACTURE, > 3 RIBS ON ONE SIDE AND <= 3 RIBS ON OTHER SIDE, STABLE CHEST OR NFS, WITH HEMO/PNEUMO THORAX	42	0.902	1.075	1.065	1.086
441406.3	LUNG, CONTUSION, UNILATERAL	68	0.903	1.039	1.031	1.048
450230.3	RIB CAGE, FRACTURE, > 3 RIBS ON ONE SIDE AND <= 3 RIBS ON OTHER SIDE, STABLE CHEST OR NFS	40	0.923	1.074	1.062	1.086
450222.3	RIB CAGE, FRACTURE, 2-3 RIBS ANY LOCATION OR MULTIPLE FRACTURES OF SINGLE RIB, WITH STABLE CHEST OR NFS WITH HEMO/PNEUMOTHORAX	42	0.903	1.076	1.066	1.086
450242.5	RIB CAGE, FRACTURE, > 3 RIBS ON EACH OF TWO SIDES, WITH STABLE CHEST OR NFS, WITH HEMO/PNEUMO THORAX	40	0.879	1.068	1.052	1.084
442202.3	THORACIC CAVITY INJURY NFS WITH HEMO/PNEUMOTHORAX	40	0.890	1.067	1.061	1.073
441410.4	LUNG, CONTUSION, BILATERAL	40	0.870	1.073	1.064	1.081
450266.5	RIB CAGE, FRACTURE, FLAIL (UNSTABLE CHEST WALL), BILATERAL	56	0.792	1.013	0.990	1.036
450214.3	RIB CAGE, FRACTURE, 1 RIB, WITH HEMO/PNEUMOTHORAX	63	0.903	1.013	0.996	1.030
450264.4	RIB CAGE, FRACTURE, FLAIL CHEST (UNSTABLE CHEST WALL), WITH LUNG CONTUSION	41	0.856	1.077	1.063	1.092

Abdomen Injury Thresholds

544224.3	SPLEEN, LACERATION, MODERATE (NO HILAR OR SEGMENTAL PARENCHYMAL DISRUPTION OR DESTRUCTION; > 3CM DEEP; WITH MAJOR VESSEL INVOLVEMENT)	51	0.907	1.038	1.020	1.057
541824.3	LIVER, LACERATION, MODERATE (> 3CM DEEP, WITH MAJOR DUCT INVOLVEMENT; BLOOD LOSS > 20% BY VOLUME)	68	0.906	1.044	1.029	1.060
544226.4	SPLEEN, LACERATION, MAJOR (INVOLVING SEGMENTAL PARENCHYMAL DISRUPTION OR DESTRUCTION WITH NO HILAR INJURY)	51	0.865	1.067	1.046	1.089
543800.3	RETROPERITONEUM HEMORRHAGE OR HEMATOMA	65	0.860	1.030	1.018	1.043
541826.4	LIVER, LACERATION, MAJOR (DISRUPTION OF < 50% OF HEPATIC PARENCHYMA; MULTIPLE LACERATION > 3CM DEEP; BURST INJURY)	40	0.885	1.066	1.047	1.086
541828.5	LIVER, LACERATION, MASSIVE, COMPLEX (DISRUPTION OF > 50% OF CENTRAL HEPATIC VASCULAR SYSTEM AND INVOLVING RETROHEPATIC VENA CAVA/ HEPATIC VEIN/HEPATIC ARTERY/PORTAL VEIN/MAJOR DUCT)	43	0.854	1.024	0.990	1.059
544228.5	SPLEEN, LACERATION, MASSIVE (WITH HILAR DISRUPTION; TISSUE LOSS; AVULSION; STELLATE)	58	0.865	1.001	0.981	1.022
541424.3	JEJUNUM-ILEUM, LACERATION, PERFORATION (FULL THICKNESS BUT NOT COMPLETE TRANSECTION)	79	0.854	1.038	1.014	1.062
541624.3	KIDNEY, LACERATION, MODERATE (> 1CM BUT NO CORTEX INVOLVEMENT OR URINARY EXTRAVASATION)	59	0.941	1.045	1.001	1.091

Spinal Injury Thresholds

Body Region 6 -- Spine						
650224.3	CERVICAL SPINE, DISC, FRACTURE WITHOUT CORD CONTUSION OR LACERATION WITH OR WITHOUT DISLOCATION, LAMINA	57	0.903	1.038	1.019	1.058
650222.3	CERVICAL SPINE, FRACTURE WITHOUT CORD CONTUSION OR LACERATION WITH OR WITHOUT DISLOCATION, FACET	54	0.928	1.095	1.077	1.113
650228.3	CERVICAL SPINE, DISC, FRACTURE WITHOUT CORD CONTUSION OR LACERATION WITH OR WITHOUT DISLOCATION, ODONOTOID (DENS)	85	0.901	1.061	1.045	1.077
650226.3	CERVICAL SPINE, DISC, FRACTURE WITHOUT CORD CONTUSION OR LACERATION WITH OR WITHOUT DISLOCATION, PEDICLE	82	0.923	1.098	1.068	1.130
650634.3	LUMBAR SPINE, FRACTURE WITHOUT CORD CONTUSION OR LACERATION WITH OR WITHOUT DISLOCATION, VERTEBRAL BODY, MAJOR COMPRESSION (>20% LOSS OF HEIGHT)	81	0.980	1.087	1.038	1.137

Spinal Injury Thresholds Cont.

650434.3	THORACIC SPINE, FRACTURE WITHOUT CORD CONTUSION OR LACERATION WITH OR WITHOUT DISLOCATION, VERTEBRAL BODY, COMPRESSION (>20% LOSS OF HEIGHT)	41	0.917	1.115	1.074	1.157
640204.3	CERVICAL SPINE, CORD CONTUSION, WITH TRANSIENT NEUROLOGICAL SIGNS, WITH FRACTURE	72	0.955	1.020	0.968	1.074
650234.3	CERVICAL SPINE, DISC, FRACTURE WITHOUT CORD CONTUSION OR LACERATION WITH OR WITHOUT DISLOCATION, VERTEBRAL BODY, MAJOR COMPRESSION (>20% OF HEIGHT)	49	0.979	1.353	1.139	1.607
650424.3	THORACIC SPINE, FRACTURE WITHOUT CORD CONTUSION OR LACERATION WITH OR WITHOUT DISLOCATION, LAMINA	50	0.923	1.131	1.071	1.194
650422.3	THORACIC SPINE, FRACTURE WITHOUT CORD CONTUSION OR LACERATION WITH OR WITHOUT DISLOCATION, FACET	60	0.953	1.003	0.921	1.093

Upper Extremity Injury Thresholds

Body Region 7 – Upper Extremities						
752804.3	RADIUS FRACTURE, OPEN/DISPLACED/COMMINUTED	40	0.940	1.069	1.055	1.083
753204.3	ULNA FRACTURE, OPEN/DISPLACED/COMMINUTED	50	0.939	1.084	1.065	1.103
752604.3	HUMERUS FRACTURE, OPEN/DISPLACED/COMMINUTED	40	0.928	1.068	1.055	1.082
711000.3	AMPUTATION (TRAUMATIC) AT ANY POINT OF EXTREMITY EXCEPT FINGER	40	0.953	1.066	1.013	1.122

Lower Extremity Injury Thresholds

Body Region 8 – Lower Extremities						
852604.3	PELVIS, FRACTURE, WITH OR WITHOUT DISLOCATION, OPEN/DISPLACED/COMMINUTED	60	0.909	1.070	1.060	1.080
851814.3	FEMUR, FRACTURE, SHAFT	46	0.922	1.067	1.053	1.082
853422.3	TIBIA, SHAFT, OPEN/DISPLACED/COMMINUTED	51	0.930	1.068	1.055	1.082
851822.3	FEMUR, FRACTURE, SUPRACONDYLAR	73	0.854	1.043	1.020	1.067
851614.3	FIBULA, FRACTURE, BIMALLEOLAR OR TRIMALLEOLAR, OPEN/DISPLACED/COMMINUTED	81	0.928	1.059	1.032	1.087

Lower Extremity Injury Thresholds Cont.

852800.3	SACROILIUM FRACTURE WITH OR WITHOUT DISLOCATION	71	0.901	1.067	1.054	1.080
853408.3	TIBIA, FRACTURE, CONDYLES (PLATEAU), OPEN/DISPLACED/COMMINUTED	79	0.922	1.048	1.031	1.065
851810.3	FEMUR, FRACTURE, INTERTROCHANTERIC	53	0.879	1.049	1.031	1.067
853000.3	SYMPHYSIS PUBIS SEPARATION (FRACTURE)	46	0.909	1.079	1.065	1.093
851812.3	FEMUR, FRACTURE, NECK	56	0.919	1.045	1.024	1.067

Conclusions

- This is a comprehensive method to identify age thresholds where injury becomes especially lethal
- Allows for refinements to be made to the overall prediction

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