The Likelihood of Human Casualty in Highway Crashes -- Fourteenth Briefing: Comprehensive Characterization of Compelling Injuries

Based on an Investigation Conducted for
the FHWA/NHTSA Crash Analysis Center
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"The Likelihood of Casualty in Highway Crashes"

Introduction

This fourteenth briefing concerning the cited subject presents the following: (a) summary of progress to date in findings; (b) a comprehensive characterization of compelling injuries and occupants injured with such injuries; (c) compelling injury rates and their sensitivity to pivotal attributes; (d) a further dissertation on the sensitivity/false-positive impass; (e) an introduction to the complexities of multiple injuries per occupant; and (f) a list of research topics for further progress.

Summary of Progress to Date

1. Development and evaluation of comprehensive relations between car crash casualties and car, crash, and occupant attributes, irrespective of any ACN or Triage considerations. Development, evaluation, and illustration of fully programmable algorithms that assist in a succinct and insightful representation of the highway crash environment.

2. Development, evaluation, and illustration of algorithms for ACN applications. Projection of probabilities of crashed cars with at least one occupant at MAIS=1+, 2+, 3+, or fatality, as a function of Delta V, Direction of Force, Rollover Occurrence, and Travel Speed (when available).

3. Triage oriented development of algorithms projecting quantitatively the likelihood of a car occupant injured with at least one compelling injury (in contrast to any injury). Emphasis on predictors drawn from crash scene observables, in various numbers and combinations. Extensive evaluation of predictive merits and limitations.

4. Comprehensive Characterization of Compelling Injuries and Car Occupants with Such Injuries. The findings of this topic are reported fully in this briefing.

Comprehensive Characterization of Compelling Injuries.

The designation of compelling injuries has been performed by Champion et al in several steps: at first by using the AIS90 protocol (August 1996); then by addressing the NCSA sponsored translation of AIS90 to OIC protocol (September 1996); and by further revisions (October 1996).

In this briefing compelling injuries are characterized by fully decoded region, organ/system, lesion, ais, frequency, and annual U.S. incidence. A comprehensive list is presented in Table A-1, page 13.

Compelling injuries are compared with noncompelling in Table A-2, page 19, for AIS=3, where both compelling and noncompelling injuries occur. Recall that all injuries with AIS < 3 have been axiomatically defined as noncompelling, while at AIS > 3 all injuries are compelling. Table A-2 allows qualified readers to raise questions and propose revisions concerning the compelling or noncompelling nature injuries at AIS=3.

Incidence of Compelling Injury Populations and Subpopulations

The mother population in this investigation is that of all car occupants involved in towaway car crashes, irrespective of injury. The primary source of data is the NASS/CDS 1988-1995. From this data source we determine incidence (averaged over the eight years 1988-1995). Addressing first the injuries of injured occupants, we find:

(A)	Injury Population	Annual U.S. Incidence	Percent of Total
1	All Injuries	4,001,500	100.0
2	Noncompelling	3,911,000	97.7
3	Compelling	90,500	2.3
(B)	Compelling Inj. Subpop.		
1	All Compelling	90,500	100.0
2	Compelling of Survivors	49,539	54.7
3	Compelling of Fatalities	40,961	45.3

Incidence of Crash Involved Occupant Subpopulations

In a similar fashion we determine the incidence of towaway crash involved car occupants and the subpopulations thereof:

(C)	Crash Involved Car Occupants	Annual U.S. Incidence	Percent of Total
1	All Crash Involved	3,363,866	100.0
2	All Injured	1,595,446	47.4
3	All Uninjured	1,768,420	52.6

(D)	Alternative Partition		
	==========		
1	All Crash Involved	3,363,866	100.0
2	Injured w Compelling Injury	54,381	1.6
3	Noncompelling & Uninjured	3,309,485	98.4
(E)	Subpopulations of Injured w Compelling Injury		
	==========		
1	All with Compelling Injury	54,381	100.0
2	Survivors w Compelling Injury	34,672	63.8
3	Fatalities (Assumed Compelling)	19,750	36.2
(F)	Alternative Partition		
	==========		
1	All with Compelling Injury	54,381	100.0
2	Fully Diagnosed Injury	47,687	87.7
3	Nondiagnosed Fatalities	6,694	12.3

Pivotal Attributes of Compelling and Other Injuries

In order to develop perspective, compelling injuries are partitioned into various subpopulations and then compared to subpopulations of all other injuries. These comparisons emphasize pivotal attributes such as: (a) information sources and confidence levels, see Tables A-3 and A-7, pages 23 and 27; (b) injury severities and injured body regions, see Table A-4, page 24; (c) injured organs or anatomical systems, see Table A-5, page 25; and (d) injuring lesions, see Table A-6, page 26.

Important Attributes of Injured Occupants

For further perspective, the population of occupants with compelling injuries is addressed. This population is partitioned into various subpopulations and then compared to subpopulations of all other occupants. The attributes emphasized in these comparisons are: (i) the number of concurrent injuries per occupant and the maximum injury severity, see Table A-8, page 28; (ii) treatment received and medical facility for initial treatment, see Table A-9, page 29; (iii) Glasgow Scores and whether blood was given at facility for initial treatment, see Table A-10, page 30; and (iv) length of hospitalization, irrespective of death, and time to death irrespective of hospitalization, see Table A-11, page 31.

Rate of Occupants with Compelling Injury

The rate of occupants with a compelling injury, expressed per one hundred crash involved occupants, is a concept virtually identical to the "probability of a crash involved occupant being found with at least one compelling injury", a concept that has been used extensively in earlier briefings.

The cited rate in general, i.e. without any delimiters or qualifications is about 1.62, as may be seen in entry (D) 2 on page 3. This rate is a sensitive function of conditions associated with specific subpopulations, concerning crash, car, and occupant attributes as shown in the lengthy dissertation that follows.

Note in these results, that each crash, car, or occupant condition is accompanied by a frequency of occurrence among all crash involved occupants. The shown frequencies add to 100% in each cluster, representing all crash involved occupants. In each entry the rate of occupants with a compelling injury is presented, as a means of quantifying the rate sensitivity to the corresponding condition. Rate differences, either within a cluster or among different clusters, may be appreciated as significant or not with the help of the standard error that accompanies each and every rate.

Rate Sensitivity to Various Conditions

This sensitivity is shown in the following tabulations:

Type of Crash and Collision Partner

	Frequency Percent	Compelling Injury Rate %	+/-
Single	24.58	3.43	0.14
wHvy	30.44	2.07	0.11
wCar	44.98	1.46	0.07
	100.00		

Rollover Occurence

	Frequency Percent	Compelling Rate %	Injury +/-
R/O	5.95	5.87	0.38
NoR/O	94.05	1.89	0.06

General Area of Damage

	Frequency Percent	Compelling Rate %	Injury +/-
Front	57.74	2.32	0.10
SideP	22.77	4.49	0.21
SideNP	9.07	0.88	0.22
Rear	10.42	0.61	0.09

Principal Direction of Force

	Frequency Percent	Compelling Rate %	Injury +/-
Front	60.99	2.28	0.10
Side	27.10	3.15	0.18
Rear	11.91	0.63	0.09

Max Crush, inches

	Frequency Percent	Compelling Rate %	Injury +/-
< 24	93.15	1.55	0.07
25-48	6.43	12.42	0.64
49-Hi	0.41	29.64	3.27

Extent of Damage (CDC)

	Frequency Percent	Compelling Rate %	Injury +/-
Zone1	34.04	0.29	0.04
Zone2	34.69	1.51	0.12
Zone3	19.30	4.05	0.20
Zone4	5.56	10.12	0.65
Zone5	2.06	12.72	1.37

Delta V

	Frequency Percent	Compelling Rate %	Injury +/-
0-5mph	1.96	0.11	0.07
6-10	26.83	0.25	0.06
11-15	38.76	0.92	0.13
16-20	20.20	2.23	0.19
21-25	8.26	6.72	0.55
26-30	2.30	14.91	1.24
31-35	0.98	20.79	2.35
36-40	0.40	37.10	3.91
41-Hi	0.31	49.01	4.90

Loss of Integrity of Pax Compartment

	Frequency Percent	Compelling Rate %	Injury +/-
Loss	20.75	6.94	0.22
NoLoss	79.25	0.87	0.04

Intrusion (12 inches or more in Front)

	Frequency Percent	Compelling Rate %	Injury +/-
Intru	15.34	8.76	0.28
NoIntr	84.66	0.93	0.04

Seat Failure

	Frequency Percent	Compelling Rate %	Injury +/-
Fail	2.36	10.96	0.82
NoFail	97.64	1.92	0.05

Rim Deformation (one inch or more)

	Frequency Percent	Compelling Rate %	Injury +/-
RimDef	8.19	7.51	0.37
NoDef	91.81	1.65	0.05

Fire Occurrence

	Frequency Percent	Compelling Rate %	Injury +/-
Fire	0.16	25.23	5.05
NoFire	99.84	2.09	0.06

Car Size

Car Size	Frequency Percent	Compelling Rate %	Injury +/-
Small	12.24	2.76	0.21
Mid	53.84	2.11	0.08
Large	33.93	2.03	0.09

Occupant's Age

	Frequency Percent	Compelling Rate %	Injury +/-
< 36 Yrs	68.77	1.86	0.06
36-55	19.63	2.21	0.14
> 55 Yrs	11.60	4.05	0.22

Occupant's Gender

	Frequency Percent	Compelling Rate %	Injury +/-
Male	51.08	2.32	0.08
Female	48.92	2.01	0.08

Occupant's Weight, lbs

	Frequency Percent	Compelling Rate %	Injury +/-
< 121	23.51	1.64	0.11
121-180	57.08	2.50	0.10
181-Hi	19.41	2.66	0.16

Occupant's Height, inches

	Frequency Percent	Compelling Rate %	Injury +/-
< 62	12.92	1.52	0.15
62-72	78.95	2.45	0.08
73-Hi	8.13	2.34	0.21

Seating Position

	Frequency Percent	Compelling Rate %	Injury +/-
Driver	65.10	2.31	0.08
FrPax	21.22	1.99	0.11
RrPax	13.68	1.49	0.12

Abnormal Posture

	Frequency Percent	Compelling Rate %	Injury +/-
AbnPos	3.50	2.03	0.29
NoAbno	96.50	2.13	0.06

Occupant Restraint Protection

	Frequency Percent	Compelling Rate %	Injury +/-
Unrest	28.35	4.08	0.14
Belt	57.33	1.34	0.07
BltBag	1.97	1.18	0.21
Unkn	12.34	1.45	0.11

Occupant Ejection

	Frequency Percent	Compelling Rate %	Injury +/-
Complt	0.70	31.05	2.10
Partl	0.53	30.66	2.45
NoEjct	98.78	1.77	0.05

Occupant Entrapment

	Frequency Percent	Compelling Injury Rate %	+/-
Entrap	0.40	47.02	3.30
NoEntr	99.60	1.95	0.05

Occurrence of Other Occupant w Serious Inj.

	Frequency Percent	Compelling Injury Rate %	+/-
Othrin	0.71	57.36	1.65
NoOthr	99.29	1.73	0.05

Notes of Caution

Rates as presented above are very useful in making sensitivity determinations and in identifying influential conditions. However, beyond a consideration of the standard errors in evaluating rate differences, serious thought should be given to the ever present danger of confounding effects.

For example, the different rates encountered among entries of various occupant restraint use (see page 8), may not be entirely due to restraint effects, as we know that crash severity may differ quite substantially among the populations at issue. Similarly confounding effects, due to an occupant's age, may be in action in the results concerning an occupant's weight and height, see pages 7 and 8.

For these reasons, and in order to minimize these confounding influences, all analyses of this type should be conducted with a simultaneous resolution over all values of the attributes of interest. This, of course becomes very cumbersome and eventually leads to the categorical analyses and logistic regressions that are being adressed in this investigation.

Revisiting an Impass

One of the important questions in this investigation is: "can we identify conditions or domains of conditions that lead to: (a) a high rate of occupants with compelling injury, but (b) without a high rate of other occupants?". The answer to this question is: "readily yes" to part (a), but "no so far" to part (b).

This impass of our being unable to capture the majority of occupants with compelling injury, without also capturing a large population of noncompelling occurrences (false positives), is revisited and illustrated here without the complexities of treatment by logistic regression or other rather intractable analyses.

Notice two things in the results concerning sensitivity of compelling injury rates, pages 4 to 9: (a) many conditions of high compelling rates are evident, e.g. high Delta V values, Intrusion, Ejection, Entrapment, etc.; and (b) conditions associated with high compelling rates are also associated with low incidence.

This dual situation is amplified when bivariate or multivariate joint conditions are addressed. As an example we are addressing here the joint distribution of the five attributes: Delta V, General Area of Damage, Restraint Use, Occupant's Age, and Ejection, with the resolution used in pages 6, 5, 8, 7, and 8, respectively, for the univariate distributions.

The number of resulting joint conditions, 1296, is too large to be tabulated here individually, but the fact remains that for several joint conditions the compelling rate is approaching 100%, however only for conditions of rather low frequency. The converse is also readily observed, as may be seen in Fig. 1.

This disappointing situation is compounded by the fact that the noncompelling condition (i.e. occupants with noncompelling injury and uninjured occupants) shows an opposite trend, as may be seen in Fig. 2. The extent of the compounded disappointment is evident in Fig. 3, where the data of Figs 1 and 2 are superimposed.

It is apparent that, under the cited conditions, any threshold rate or probability established for capturing a large fraction of compelling injury situations, will also capture an inordinately large fraction of the noncompelling situations. This is shown in Fig. 4. In fact, the disappointing results of Fig. 4 become more disappointing and perhaps forbidding when translated in annual incidence counts in the U.S. This is shown in Fig. 5.

Conclusion about the Impass

At this time it is not clear whether or how the cited impass may be overcome, and not clear whether or not blanket conditions can be defined for compelling injury occurrence. It is clear, however, that the occurrence of compelling injury situations can

be defined quantitatively and with high resolution. Rates or probabilities of occurrence can play an adjunct role in triage decisions, in conjunction with anatomy and pathology scores, especially when these scores are not entirely decisive.

An Introduction to the Complexities of Multiple Injuries

When dealing with the evaluation of injuries and injury outcomes, highway casualty analysts usually address aggregate injuries, whether all or the most severe per injured person. Although convenient, this process disregards the important relationships between a person's injury multiplicity and profile, and the possible injury outcomes or the need for abating such outcomes.

Reference to Table A-8, page 28, shows that 25% of all injured car occupants, i.e. nearly 400,000 people per year in the U.S., have more than 3 injuries. This percentage rises to 75% of those who are seriously or severely injured. In this population, 25% have more than 10 injuries, and nearly 5% have mere than 20 injuries per person. The fraction of those with more than 10 injuries is about 40% for fatalities.

Even the most sophisticated analyses, are currently limited to the most severe injury only, without consideration of the role played by other injuries per person in determining this person's needs for specific treatment, fatality prevention, or abatement of outcome severity for survivors.

The strong influence of multiple injuries on the threat to life is illustrated in Fig. 6, and with more resolution in Fig. 7. The cited concerns, plus a continuing progress in injury and casualty data collection and analyses, suggest the appropriateness and timeliness of initiating and executing work towards better understanding of the role of multiple injuries, and eventually towards applying the findings of such work in fatality prevention and injury outcome abatement.

Indeed, currently available data may allow the examination of multiple injury effects on important dichotomous variables such as:

- Fatality;
- Need for Trauma Center Initial Treatment;
- Survival with Hospitalization Exceeding 30 Days;
- Survival with 6 to 30 Days Hospitalization;
- Survival with Short Hospitalization (1 to 5 days);
- Ambulance but no Hospitalization;

Furthermore, if the data volume allows it, fatalities can be further resolved according to "time to death", "emergency measures", and "medical facility" variables.

On Research Topics for Further Progress
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(a) Additional and alternative attempts to overcome current limitations in broad triage applications, i.e. overcome the sensitivity/false-positive impass.
(b) Formulation and evaluation of limited but still useful triage applications, in case that cited limitations persist.
(c) Finalization of ACN algorithms, both for near term (i.e. CALSPAN black box) applications, and especially for projected applications based on a broader spectrum of predictors, whether measured by car sensors or observed at the crash scene.
(d) Determination of the role of multiple injuries per occupant in influencing outcome severity.
(e) Updates, as soon as NASS 1996 becomes available; and extensions to include pre-1988 NASS years, in order to enhance sample volumes, address nontowaway crashes, and review sensitivity to crash and car vintages.
(f) Expand the populations to address vehicles other than cars, other occupants, and nonoccupants (pedestrians, cyclists and motorcyclists).

Table A-1. Full Identification of Towaway Car Occupant Compelling Injuries; The NASS/CDS 1988-1995

Count: Annual Incidence in the U.S.
Pais: Percent within Shown AIS Group
Ptotal: Percent of All Known Compelling Injuries

AIS	Region	Organ	Lesion	Count	Pais	Ptotal
3	Chest	Lung(s)	Contusion	10346	18.70	11.43
3	Head	Brain	Unknown	5896	10.66	6.52
3	Head	Skeletal	Fracture	4782	8.64	5.28
3	Head	Brain	Contusion	4266	7.71	4.71
3	Head	Brain	Concussion	4204	7.60	4.65
3	Pelvis	Skeletal	Fracture	3832	6.93	4.23
3	Chest	Heart	Contusion	3599	6.51	3.98
3	Face	Skeletal	Fracture	2917	5.27	3.22
3	Chest	Unknown	Unknown	2634	4.76	2.91
3	Neck	Skeletal	Fracture	1680	3.04	1.86
3	Chest	Lung(s)	Laceration	1505	2.72	1.66
3	Abdmn	Spleen	Laceration	865	1.56	0.96
3	Abdmn	Digestive	Laceration	806	1.46	0.89
3	Chest	Lung(s)	Puncture	687	1.24	0.76
3	Abdmn	Respirtry	Laceration	593	1.07	0.65
3	Abdmn	Liver	Laceration	498	0.90	0.55
3	Abdmn	Respirtry	Rupture	482	0.87	0.53
3	Abdmn	Arterial	Laceration	415	0.75	0.46
3	Neck	Cpine	Contusion	410	0.74	0.45
3	Abdmn	Spleen	Rupture	381	0.69	0.42
3	Face	Integum.	Avulsion	362	0.65	0.40
3	Chest	Lung(s)	Unknown	321	0.58	0.35
3	Chest	Arterial	Laceration	302	0.55	0.33
3	Back	Cpine	Contusion	212	0.38	0.23
3	Knee	Joint(s)	Avulsion	198	0.36	0.22
3	Abdmn	Liver	Contusion	185	0.33	0.20
3	Head	Integum.	Avulsion	183	0.33	0.20
3	Chest	Respirtry	Laceration	172	0.31	0.19
3	Neck	Vertebrae	Dislocation	160	0.29	0.18
3	Abdmn	Urogenitl	Laceration	139	0.25	0.15
3	Wrist Hnd	All	Crush	136	0.25	0.15
3	Neck	Vertebrae	Rupture	127	0.23	0.14
3	Face	Eye(s)	Avulsion	122	0.22	0.14
3	Abdmn	Kidney(s)	Laceration	118	0.21	0.13
3	Ankle, Ft	All	Crush	110	0.20	0.12
3	Abdmn	Kidney(s)	Contusion	103	0.19	0.11
3	Chest	Heart	Unknown	92	0.17	0.10
3	Neck	Arterial	Laceration	82	0.15	0.09
3	Forearm	All	Crush	79	0.14	0.09
3	Abdmn	Arterial	Unknown	75	0.14	0.08
3	Shldr	All	Crush	74	0.13	0.08

3	Head	Arterial	Unknown	64	0.12	0.07
3	Chest	Digestive	Laceration	62	0.11	0.07
3	Upr Limbs	All	Amputation	61	0.11	0.07
3	Lower Leg	Integum.	Avulsion	57	0.10	0.06
3	Wrist Hnd	Integum.	Avulsion	56	0.10	0.06
3	Knee	All	Crush	55	0.10	0.06
3	Chest	Heart	Laceration	53	0.10	0.06
3	Upr Limbs	All	Crush	52	0.09	0.06
3	Upr Limbs	Arterial	Laceration	48	0.09	0.05
3	Chest	Respirtry	Contusion	42	0.08	0.05
3	Lower Leg	All	Amputation	42	0.08	0.05
3	Head	Brain	Avulsion	40	0.07	0.04
3	Lwr Limbs	Integum.	Avulsion	40	0.07	0.04
3	Chest	Digestive	Contusion	34	0.06	0.04
3	Abdmn	Digestive	Rupture	31	0.06	0.03
3	Abdmn	Digestive	Contusion	30	0.05	0.03
3	Abdmn	Integum.	Laceration	29	0.05	0.03
3	Lower Leg	All	Crush	28	0.05	0.03
3	Ankle, Ft	All	Amputation	28	0.05	0.03
3	Abdmn	Spleen	Contusion	26	0.05	0.03
3	Lwr Limbs	All	Crush	26	0.05	0.03
3	Chest	Integum.	Avulsion	24	0.04	0.03
3	Chest	Arterial	Unknown	22	0.04	0.02
3	Ankle, Ft	Integum.	Avulsion	21	0.04	0.02
3	Lwr Limbs	All	Amputation	21	0.04	0.02
3	Neck	Arterial	Unknown	16	0.03	0.02
3	Forearm	Integum.	Avulsion	15	0.03	0.02
3	Elbow	All	Crush	14	0.02	0.01
3	Knee	Arterial	Laceration	14	0.03	0.02
3	Head	Arterial	Laceration	13	0.02	0.01
3	Abdmn	Digestive	Avulsion	13	0.02	0.01
3	Head	Brain	Laceration	12	0.02	0.01
3	Abdmn	Gland(s)	Laceration	12	0.02	0.01
3	Head	Muscle(s)	Avulsion	10	0.02	0.01
3	Back	Integum.	Avulsion	9	0.02	0.01
3	Thigh	Integum.	Avulsion	9	0.02	0.01
3	Wrist Hnd	All	Amputation	8	0.02	0.01
3	Upper Arm	Integum.	Avulsion	6	0.01	0.01
3	Face	Muscle(s)	Avulsion	5	0.01	0.01
3	Knee	Arterial	Total Sever.	5	0.01	0.01
3	Abdmn	Urogenitl	Avulsion	4	0.01	0.00
3	Upper Arm	All	Amputation	3	0.01	0.00
3	Knee	Integum.	Avulsion	3	0.01	0.00
3	Pelvis	Muscle(s)	Avulsion	3	0.00	0.00
3	Head	Arterial	Other	2	0.00	0.00
3	Forearm	All	Amputation	2	0.00	0.00
3	Neck	Nerve(s)	Avulsion	1	0.00	0.00
3	Pelvis	Integum.	Avulsion	1	0.00	0.00
	All Compelling @ MAIS=3			55322	100.0	61.1

AIS	Region	Organ	Lesion	Count	Pais	Ptotal
4	Chest	Skeletal	Fracture	5372	24.82	5.94
4	Head	Brain	Unknown	4965	22.94	5.49
4	Chest	Lung(s)	Contusion	1340	6.19	1.48
4	Head	Skeletal	Fracture	1194	5.51	1.32
4	Head	Brain	Concussion	1175	5.43	1.30
4	Chest	Heart	Contusion	1014	4.68	1.12
4	Abdmn	Liver	Laceration	866	4.00	0.96
4	Chest	Arterial	Laceration	846	3.91	0.94
4	Head	Brain	Laceration	702	3.24	0.78
4	Chest	Lung(s)	Laceration	612	2.83	0.68
4	Chest	Unknown	Unknown	530	2.45	0.59
4	Face	Skeletal	Fracture	329	1.52	0.36
4	Abdmn	Urogenitl	Rupture	306	1.41	0.34
4	Abdmn	Digestive	Laceration	276	1.28	0.31
4	Chest	Heart	Laceration	263	1.21	0.29
4	Abdmn	Spleen	Laceration	189	0.87	0.21
4	Abdmn	Arterial	Laceration	179	0.83	0.20
4	Neck	Cpine	Unknown	177	0.82	0.20
4	Abdmn	Urogenitl	Laceration	137	0.63	0.15
4	Neck	Cpine	Contusion	98	0.45	0.11
4	Chest	Respirtry	Fracture	95	0.44	0.11
4	Head	Brain	Contusion	79	0.36	0.09
4	Chest	Arterial	Unknown	67	0.31	0.07
4	Abdmn	Digestive	Rupture	58	0.27	0.06
4	Abdmn	Arterial	Total Sever.	56	0.26	0.06
4	Abdmn	Kidney(s)	Laceration	56	0.26	0.06
4	Pelvis	All	Crush	55	0.25	0.06
4	Back	Cpine	Contusion	38	0.18	0.04
4	Abdmn	Digestive	Avulsion	35	0.16	0.04
4	Neck	Respirtry	Laceration	32	0.15	0.04
4	Abdmn	Urogenitl	Avulsion	31	0.14	0.03
4	Abdmn	Liver	Rupture	29	0.14	0.03
4	Lwr Limbs	All	Amputation	29	0.13	0.03
4	Back	Cpine	Unknown	28	0.13	0.03
4	Chest	Arterial	Rupture	28	0.13	0.03
4	Chest	Heart	Rupture	28	0.13	0.03
4	Neck	Arterial	Laceration	27	0.13	0.03
4	Chest	Digestive	Laceration	26	0.12	0.03
4	Neck	Arterial	Total Sever.	26	0.12	0.03
4	Chest	Arterial	Total Sever.	25	0.12	0.03
4	Abdmn	Arterial	Rupture	2	0.11	0.03
4	Chest	Respirtry	Laceration	2	0.11	0.03
4	Thigh	All	Amputation	2	0.09	0.02
4	Chest	Arterial	Other	1	0.08	0.02
4	Chest	Lung(s)	Puncture	18	0.08	0.02
4	Head	Arterial	Total Sever.	14	0.06	0.02
4	Ankle, Ft	Joint(s)	Fract., Disl	14	0.06	0.01

4	Abdmn	Kidney(s)	Rupture	11	0.05	0.01
4	Thigh	Arterial	Laceration	11	0.05	0.01
4	Head	Arterial	Laceration	10	0.05	0.01
4	Back	Cpine	Laceration	9	0.04	0.01
4	Neck	Cpine	Other	9	0.04	0.01
4	Neck	Cpine	Rupture	9	0.04	0.01
4	Chest	Respirtry	Other	6	0.03	0.01
4	Chest	Muscle(s)	Contusion	5	0.02	0.01
4	Chest	All	Crush	5	0.02	0.01
4	Abdmn	Liver	Contusion	5	0.02	0.01
4	Abdmn	Urogenitl	Unknown	4	0.02	0.00
4	Unknown	Unknown	Other	4	0.02	0.00
4	Abdmn	Urogenitl	Detachment	3	0.01	0.00
4	Abdmn	Spleen	Rupture	2	0.01	0.00
4	Abdmn	Unknown	Unknown	2	0.01	0.00
4	Chest	Integum.	Abrasion	1	0.00	0.00
4	Head	Brain	Rupture	1	0.01	0.00
4	Knee	Arterial	Laceration	1	0.00	0.00
4	Abdmn	Respirtry	Laceration	1	0.01	0.00
	All Compelling @ MAIS=4			21650	100.0	24.0

AIS	Region	Organ	Lesion	Count	Pais	Ptotal
5	Head	Brain	Concussion	2764	27.82	3.05
5	Head	Brain	Unknown	1191	11.99	1.32
5	Chest	Skeletal	Fracture	991	9.98	1.10
5	Chest	Heart	Laceration	974	9.80	1.08
5	Head	Brain	Contusion	638	6.43	0.71
5	Chest	Arterial	Laceration	576	5.80	0.64
5	Abdmn	Spleen	Laceration	450	4.53	0.50
5	Abdmn	Liver	Laceration	311	3.13	0.34
5	Chest	Arterial	Rupture	224	2.25	0.25
5	Back	Cpine	Total Sever.	183	1.84	0.20
5	Abdmn	Liver	Rupture	163	1.64	0.18
5	Chest	Lung(s)	Laceration	151	1.52	0.17
5	Back	Cpine	Laceration	95	0.96	0.10
5	Abdmn	Spleen	Rupture	92	0.93	0.10
5	Neck	Cpine	Laceration	90	0.91	0.10
5	Abdmn	Kidney(s)	Rupture	86	0.87	0.10
5	Abdmn	Kidney(s)	Avulsion	80	0.80	0.09
5	Neck	Cpine	Contusion	68	0.69	0.08
5	Neck	Respirtry	Laceration	65	0.65	0.07
5	Abdmn	Digestive	Rupture	64	0.65	0.07
5	Neck	Cpine	Unknown	60	0.60	0.07
5	Chest	Heart	Rupture	51	0.52	0.06
5	Abdmn	Arterial	Laceration	51	0.52	0.06
5	Back	Cpine	Contusion	46	0.46	0.05

5	Abdmn	Kidney(s)	Laceration	44	0.45	0.05
5	Chest	Heart	Unknown	41	0.41	0.05
5	Whole Bdy	Integum.	Burn	41	0.41	0.05
5	Neck	Cpine	Total Sever.	33	0.33	0.04
5	Abdmn	Digestive	Avulsion	31	0.31	0.03
5	Chest	Respirtry	Fracture	27	0.27	0.03
5	Chest	Respirtry	Laceration	27	0.27	0.03
5	Back	Cpine	Unknown	24	0.24	0.03
5	Abdmn	Spleen	Avulsion	23	0.23	0.03
5	Abdmn	Digestive	Laceration	22	0.22	0.02
5	Chest	Heart	Puncture	19	0.19	0.02
5	Chest	Lung(s)	Contusion	19	0.19	0.02
5	Abdmn	Liver	Avulsion	19	0.19	0.02
5	Head	Arterial	Laceration	17	0.17	0.02
5	Abdmn	Arterial	Rupture	17	0.17	0.02
5	Abdmn	Gland(s)	Rupture	13	0.14	0.01
5	Chest	Unknown	Unknown	10	0.10	0.01
5	Back	All	Crush	7	0.07	0.01
5	Chest	Digestive	Laceration	6	0.06	0.01
5	Neck	Arterial	Rupture	6	0.06	0.01
5	Shldr	Skeletal	Fracture	6	0.06	0.01
5	Head	Brain	Rupture	4	0.04	0.00
5	Unknown	Unknown	Unknown	3	0.03	0.00
5	Chest	Respirtry	Rupture	3	0.03	0.00
5	Abdmn	Urogenitl	Laceration	3	0.03	0.00
5	Neck	Respirtry	Total Sever.	3	0.03	0.00
5	Pelvis	All	Crush	3	0.03	0.00
5	Head	Brain	Avulsion	2	0.02	0.00
	All Compelling @ MAIS=5			9937	100.0	11.0

AIS	Region	Organ	Lesion	Count	Pais	Ptotal
6	Head	Brain	Laceration	791	22.02	0.87
6	Chest	Arterial	Total Sever.	491	13.68	0.54
6	Head	All	Crush	454	12.64	0.50
6	Chest	All	Crush	374	10.42	0.41
6	Whole Bdy	Integum.	Burn	317	8.82	0.35
6	Chest	Arterial	Laceration	274	7.63	0.30
6	Neck	Cpine	Total Sever.	269	7.50	0.30
6	Chest	Heart	Rupture	115	3.21	0.13
6	Unknown	Integum.	Burn	105	2.94	0.12
6	Neck	Cpine	Laceration	94	2.61	0.10
6	Chest	Heart	Laceration	88	2.45	0.10
6	Neck	All	Amputation	52	1.45	0.06
6	Neck	All	Crush	40	1.12	0.04
6	Unknown	Unknown	Unknown	31	0.87	0.03
6	Chest	Heart	Avulsion	22	0.61	0.02

6	Abdmn	Arterial	Total Sever.	21	0.59	0.02
6	Abdmn	All	Total Sever.	20	0.55	0.02
6	Head	Brain	Unknown	9	0.25	0.01
6	Neck	Cpine	Unknown	9	0.25	0.01
6	Head	All	Amputation	6	0.17	0.01
6	Neck	Cpine	Contusion	6	0.18	0.01
6	Chest	Heart	Unknown	1	0.03	0.00
	All Compelling @ MAIS=6			3589	100.0	4.0
Total Compelling @ MAIS=3-6				90498	100.0	100.0

Table A-2. Full Identification of Compelling and Noncompelling Injuries of towaway Car Occupants @ MAIS=3; The NASS/CDS 1988-1995

Count: Annual Incidence in the U.S.
Pgrp: Percent within Shown Group
Pall3: Percent of All Known Injuries @ MAIS=3

Compelling Injuries @ MAIS=3

Region	Organ	Lesion	Count	Pgrp	Pall3
Chest	Lung(s)	Contusion	10346	18.70	9.65
Head	Brain	Unknown	5896	10.66	5.50
Head	Skeletal	Fracture	4782	8.64	4.46
Head	Brain	Contusion	4266	7.71	3.98
Head	Brain	Concussion	4204	7.60	3.92
Pelvis	Skeletal	Fracture	3832	6.93	3.57
Chest	Heart	Contusion	3599	6.51	3.36
Face	Skeletal	Fracture	2917	5.27	2.72
Chest	Unknown	Unknown	2634	4.76	2.46
Neck	Skeletal	Fracture	1680	3.04	1.57
Chest	Lung(s)	Laceration	1505	2.72	1.40
Abdmn	Spleen	Laceration	865	1.56	0.81
Abdmn	Digestive	Laceration	806	1.46	0.75
Chest	Lung(s)	Puncture	687	1.24	0.64
Abdmn	Respirtry	Laceration	593	1.07	0.55
Abdmn	Liver	Laceration	498	0.90	0.46
Abdmn	Respirtry	Rupture	482	0.87	0.45
Abdmn	Arterial	Laceration	415	0.75	0.39
Neck	Cpine	Contusion	410	0.74	0.38
Abdmn	Spleen	Rupture	381	0.69	0.36
Face	Integum.	Avulsion	362	0.65	0.34
Chest	Lung(s)	Unknown	321	0.58	0.30
Chest	Arterial	Laceration	302	0.55	0.28
Back	Cpine	Contusion	212	0.38	0.20
Knee	Joint(s)	Avulsion	198	0.36	0.18
Abdmn	Liver	Contusion	185	0.33	0.17
Head	Integum.	Avulsion	183	0.33	0.17
Chest	Respirtry	Laceration	172	0.31	0.16
Neck	Vertebrae	Dislocation	160	0.29	0.15
Abdmn	Urogenitl	Laceration	139	0.25	0.13
Wrist Hnd	All	Crush	136	0.25	0.13
Neck	Vertebrae	Rupture	127	0.23	0.12
Face	Eye(s)	Avulsion	122	0.22	0.11
Abdmn	Kidney(s)	Laceration	118	0.21	0.11
Ankle, Ft	All	Crush	110	0.20	0.10
Abdmn	Kidney(s)	Contusion	103	0.19	0.10

Chest	Heart	Unknown	92	0.17	0.09
Neck	Arterial	Laceration	82	0.15	0.08
Forearm	All	Crush	79	0.14	0.07
Abdmn	Arterial	Unknown	75	0.14	0.07
Shldr	All	Crush	74	0.13	0.07
Head	Arterial	Unknown	64	0.12	0.06
Chest	Digestive	Laceration	62	0.11	0.06
Upr Limbs	All	Amputation	61	0.11	0.06
Lower Leg	Integum.	Avulsion	57	0.10	0.05
Wrist Hnd	Integum.	Avulsion	56	0.10	0.05
Knee	All	Crush	55	0.10	0.05
Chest	Heart	Laceration	53	0.10	0.05
Upr Limbs	All	Crush	52	0.09	0.05
Upr Limbs	Arterial	Laceration	48	0.09	0.04
Chest	Respirtry	Contusion	42	0.08	0.04
Lower Leg	All	Amputation	42	0.08	0.04
Head	Brain	Avulsion	40	0.07	0.04
Lwr Limbs	Integum.	Avulsion	40	0.07	0.04
Chest	Digestive	Contusion	34	0.06	0.03
Abdmn	Digestive	Rupture	31	0.06	0.03
Abdmn	Digestive	Contusion	30	0.05	0.03
Abdmn	Integum.	Laceration	29	0.05	0.03
Lower Leg	All	Crush	28	0.05	0.03
Ankle, Ft	All	Amputation	28	0.05	0.03
Abdmn	Spleen	Contusion	26	0.05	0.02
Lwr Limbs	All	Crush	26	0.05	0.02
Chest	Integum.	Avulsion	24	0.04	0.02
Chest	Arterial	Unknown	22	0.04	0.02
Ankle, Ft	Integum.	Avulsion	21	0.04	0.02
Lwr Limbs	All	Amputation	21	0.04	0.02
Neck	Arterial	Unknown	16	0.03	0.01
Forearm	Integum.	Avulsion	15	0.03	0.01
Elbow	All	Crush	14	0.02	0.01
Knee	Arterial	Laceration	14	0.03	0.01
Head	Arterial	Laceration	13	0.02	0.01
Abdmn	Digestive	Avulsion	13	0.02	0.01
Head	Brain	Laceration	12	0.02	0.01
Abdmn	Gland(s)	Laceration	12	0.02	0.01
Head	Muscle(s)	Avulsion	10	0.02	0.01
Back	Integum.	Avulsion	9	0.02	0.01
Thigh	Integum.	Avulsion	9	0.02	0.01
Wrist Hnd	All	Amputation	8	0.02	0.01
Upper Arm	Integum.	Avulsion	6	0.01	0.01
Face	Muscle(s)	Avulsion	5	0.01	0.00
Knee	Arterial	Total Sever.	5	0.01	0.00
Abdmn	Urogenitl	Avulsion	4	0.01	0.00
Upper Arm	All	Amputation	3	0.01	0.00
Knee	Integum.	Avulsion	3	0.01	0.00
Pelvis	Muscle(s)	Avulsion	3	0.00	0.00
Head	Arterial	Other	2	0.00	0.00

Forearm	All	Amputation	2	0.00	0.00
Neck	Nerve(s)	Avulsion	1	0.00	0.00
Pelvis	Integum.	Avulsion	1	0.00	0.00
All Compelling Injuries @ MAIS=3			55322	100.0	51.7

Noncompelling Injuries @ MAIS=3

Region	Organ	Lesion	Count	Pgrp	Pall3
Thigh	Skeletal	Fracture	12386	23.88	11.55
Chest	Skeletal	Fracture	9965	19.21	9.30
Forearm	Skeletal	Fracture	6161	11.88	5.75
Lower Leg	Skeletal	Fracture	5175	9.98	4.83
Upper Arm	Skeletal	Fracture	5049	9.73	4.71
Ankle, Ft	Skeletal	Fracture	1897	3.66	1.77
Back	Skeletal	Fracture	1536	2.96	1.43
Pelvis	Joint(s)	Fract., Disl	1312	2.53	1.22
Pelvis	Joint(s)	Dislocation	1137	2.19	1.06
Pelvis	Joint(s)	Detachment	1088	2.10	1.02
Ankle, Ft	Joint(s)	Fract., Disl	920	1.77	0.86
Wrist Hnd	Skeletal	Fracture	613	1.18	0.57
Knee	Joint(s)	Laceration	530	1.02	0.49
Wrist Hnd	Joint(s)	Fract., Disl	464	0.89	0.43
Neck	Vertebrae	Fract., Disl	445	0.86	0.41
Knee	Joint(s)	Dislocation	394	0.76	0.37
Abdmn	Unknown	Unknown	322	0.62	0.30
Elbow	Joint(s)	Fract., Disl	315	0.61	0.29
Knee	Joint(s)	Rupture	273	0.53	0.25
Neck	Respirtry	Contusion	247	0.48	0.23
Ankle, Ft	Joint(s)	Dislocation	208	0.40	0.19
Back	Vertebrae	Fract., Disl	129	0.25	0.12
Shldr	Skeletal	Fracture	123	0.24	0.11
Lwr Limbs	Skeletal	Fracture	123	0.24	0.11
Elbow	Joint(s)	Dislocation	100	0.19	0.09
Neck	Respirtry	Laceration	93	0.18	0.09
Neck	Respirtry	Fracture	87	0.17	0.08
Knee	Skeletal	Fracture	78	0.15	0.07
Back	Vertebrae	Rupture	71	0.14	0.07
Unknown	Unknown	Unknown	68	0.13	0.06
Wrist Hnd	Muscle(s)	Laceration	65	0.13	0.06
Wrist Hnd	Joint(s)	Dislocation	61	0.12	0.06
Chest	Respirtry	Unknown	52	0.10	0.05
Head	Integum.	Laceration	48	0.09	0.04
Knee	Muscle(s)	Laceration	28	0.05	0.03
Thigh	Muscle(s)	Laceration	25	0.05	0.02
Chest	Respirtry	Other	21	0.04	0.02
Face	Integum.	Laceration	16	0.03	0.01

Back	Unknown	Rupture	15	0.03	0.01
Lower Leg	Muscle(s)	Laceration	15	0.03	0.01
Chest	Respirtry	Burn	12	0.02	0.01
Chest	Skeletal	Contusion	12	0.02	0.01
Ankle, Ft	Joint(s)	Sprain	10	0.02	0.01
Upr Limbs	Skeletal	Unknown	10	0.02	0.01
Face	Integum.	Abrasion	9	0.02	0.01
Whole Bdy	Integum.	Burn	9	0.02	0.01
Pelvis	Integum.	Contusion	9	0.02	0.01
Upr Limbs	Integum.	Burn	9	0.02	0.01
Lwr Limbs	Integum.	Burn	9	0.02	0.01
Abdmn	Spleen	Puncture	8	0.02	0.01
Upr Limbs	Skeletal	Fracture	8	0.01	0.01
Lwr Limbs	Integum.	Laceration	8	0.02	0.01
Elbow	Joint(s)	Laceration	7	0.01	0.01
Abdmn	Digestive	Unknown	7	0.01	0.01
Unknown	Integum.	Burn	7	0.01	0.01
Back	Integum.	Abrasion	6	0.01	0.01
Neck	Respirtry	Unknown	6	0.01	0.01
Ankle, Ft	Joint(s)	Rupture	6	0.01	0.01
Face	Joint(s)	Fract., Disl	5	0.01	0.00
Knee	Integum.	Abrasion	5	0.01	0.00
Thigh	Arterial	Laceration	5	0.01	0.00
Upper Arm	Arterial	Laceration	4	0.01	0.00
Back	Vertebrae	Dislocation	4	0.01	0.00
Chest	Integum.	Laceration	4	0.01	0.00
Face	Eye(s)	Unknown	4	0.01	0.00
Abdmn	Muscle(s)	Laceration	4	0.01	0.00
Neck	Integum.	Burn	4	0.01	0.00
Upper Arm	Muscle(s)	Laceration	3	0.01	0.00
Face	Integum.	Unknown	3	0.01	0.00
Face	Skeletal	Contusion	3	0.01	0.00
Abdmn	Digestive	Puncture	3	0.01	0.00
Abdmn	Spleen	Unknown	3	0.00	0.00
Thigh	Nerve(s)	Laceration	3	0.00	0.00
Elbow	Integum.	Laceration	2	0.00	0.00
Face	Nerve(s)	Laceration	2	0.00	0.00
Head	Brain	Rupture	2	0.00	0.00
Abdmn	Urogenitl	Rupture	2	0.00	0.00
Thigh	Arterial	Unknown	2	0.00	0.00
Chest	Muscle(s)	Contusion	1	0.00	0.00
Knee	Joint(s)	Sprain	1	0.00	0.00
Ankle, Ft	Joint(s)	Laceration	1	0.00	0.00
Lwr Limbs	Arterial	Laceration	1	0.00	0.00
All Noncompelling Injuries @ MAIS=3			51878	100.0	48.3
All Injuries @ MAIS=3			107200	100.0	100.0

Table A-3. Composite Distribution of Compelling Injuries over Various Information Sources, at Shown Confidence Levels; the NASS/CDS 1988-1995

Information Source	Confidence	Annual US Incidence	Percent of Total
Autopsy w/o Hosp Recs	Certain	9777	10.80
Autopsy w/o Hosp Recs	Probable	9400	10.39
Autopsy w/o Hosp Recs	Possible	3353	3.71
Autopsy w/o Hosp Recs	Unknown	5958	6.58
Hosp w/o Emerg Recs	Certain	18643	20.60
Hosp w/o Emerg Recs	Probable	13985	15.46
Hosp w/o Emerg Recs	Possible	5027	5.56
Hosp w/o Emerg Recs	Unknown	7156	7.91
Emerg Recs Only	Certain	5255	5.81
Emerg Recs Only	Probable	2301	2.54
Emerg Recs Only	Possible	987	1.09
Emerg Recs Only	Unknown	1800	1.99
Private Physician	Certain	174	0.19
Private Physician	Probable	205	0.23
Private Physician	Possible	37	0.04
Private Physician	Unknown	52	0.06
Lay Coroner	Certain	318	0.35
Lay Coroner	Probable	164	0.18
Lay Coroner	Possible	35	0.04
Lay Coroner	Unknown	96	0.11
EMS Personel	Certain	4	0.00
EMS Personel	Probable	11	0.01
EMS Personel	Possible	37	0.04
EMS Personel	Unknown	16	0.02
Interviewee	Certain	2525	2.79
Interviewee	Probable	1534	1.69
Interviewee	Possible	391	0.43
Interviewee	Unknown	779	0.86
Other Unofficial	Certain	19	0.02
Other Unofficial	Unknown	28	0.03
Police	Certain	88	0.10
Police	Probable	36	0.04
Police	Possible	31	0.03
Police	Unknown	76	0.08
Unknown	Certain	28	0.03
Unknown	Probable	16	0.02
Unknown	Possible	6	0.01
Unknown	Unknown	147	0.16

Table A-4. Distribution, in Percent, of Shown Populations of Injuries over Injury Severities and Injured Body Regions; Towaway Cars in NASS/CDS 1988-1995

A: All Injuries, 4,001,500 per Yr in the U.S.;
N: Noncompelling Injuries, 3,911,000 per Yr;
C: All Compelling Injuries, 90,500 per Yr;
S: Compelling Injuries of Survivors, 49,539 per Yr;
K: Compelling Injuries of Fatalities, 40,961 per Yr;

AIS	A	N	C	S	K
1	87.23	89.24	.	.	.
2	8.18	8.37	.	.	.
3	2.68	1.33	61.13	73.63	46.02
4	0.54	.	23.92	19.04	29.82
5	0.25	.	10.98	7.25	15.49
6	0.09	.	3.97	.	8.67
Unkn	1.03	1.06	.	.	.

Region	A	N	C	S	K
Chest	8.32	7.62	38.36	35.83	41.43
Head	10.57	9.95	37.02	35.39	38.98
Abdmn	3.07	2.92	9.49	8.46	10.74
Pelvis	2.12	2.07	4.30	6.12	2.10
Face	20.62	21.00	4.13	6.37	1.42
Neck	9.06	9.17	4.03	5.22	2.60
Back	4.46	4.55	0.72	0.69	0.74
Whole Bdy	1.34	1.36	0.40	0.00	0.87
Knee	7.87	8.04	0.30	0.52	0.05
Wrist Hnd	3.95	4.04	0.22	0.34	0.07
Ankle, Ft	2.27	2.32	0.19	0.29	0.07
Upr Limbs	5.99	6.12	0.18	0.12	0.25
Lower Leg	2.68	2.74	0.14	0.15	0.13
Lwr Limbs	7.54	7.71	0.13	0.08	0.18
Forearm	1.76	1.80	0.11	0.19	0.01
Shldr	3.53	3.61	0.09	0.14	0.02
Thigh	1.82	1.86	0.04	0.03	0.06
Upper Arm	1.14	1.17	0.01	0.01	0.01
Elbow	1.33	1.36	0.01	0.03	.
Unknown	0.59	0.60	0.12	0.01	0.26

Table A-5. Distribution, in Percent, of Shown Populations of Injuries over Injured Organ/Systems;
Towaway Cars in NASS/CDS 1988-1995

A: All Injuries, 4,001,500 per Yr in the U.S.;
N: Noncompelling Injuries, 3,911,000 per Yr;
C: All Compelling Injuries, 90,500 per Yr;
S: Compelling Injuries of Survivors, 49,539 per Yr;
K: Compelling Injuries of Fatalities, 40,961 per Yr;

Organ	A	N	C	S	K
Brain	3.85	3.25	29.56	30.27	28.69
Skeletal	7.88	7.52	23.33	24.83	21.52
Lung(s)	0.39	0.01	16.58	17.33	15.67
Heart	0.17	0.01	7.03	8.06	5.79
Arterial	0.11	0.01	4.50	1.24	8.44
Liver	0.21	0.16	2.29	1.52	3.23
Spleen	0.17	0.12	2.24	2.24	2.25
Cpine	0.05	0.00	2.17	2.16	2.19
All	0.07	0.02	1.99	1.08	3.09
Respirtry	0.06	0.02	1.74	1.63	1.87
Digestive	0.64	0.62	1.65	2.21	1.09
Integum.	69.27	70.84	1.41	1.00	1.43
Urogenitl	0.06	0.04	0.69	0.57	0.85
Kidney(s)	0.15	0.14	0.55	0.44	0.68
Vertebrae	0.10	0.09	0.32	0.52	0.07
Joint(s)	2.47	2.52	0.23	0.43	.
Eye(s)	1.16	1.18	0.14	0.12	0.16
Gland(s)	0.01	0.01	0.03	.	0.06
Muscle(s)	11.63	11.90	0.02	0.04	.
Nerve(s)	0.05	0.05	0.00	0.00	.
Ear(s)	0.31	0.32	.	.	.
Unknown	1.20	1.15	3.51	4.01	2.92

Table A-6. Distribution, in Percent, of Shown Populations of Injuries over Injuring Lesions; Towaway Cars in NASS/CDS 1988-1995

A: All Injuries, 4,001,500 per Yr in the U.S.;
N: Noncompelling Injuries, 3,911,000 per Yr;
C: All Compelling Injuries, 90,500 per Yr;
S: Compelling Injuries of Survivors, 49,539 per Yr;
K: Compelling Injuries of Fatalities, 40,961 per Yr;

Lesion	A	N	C	S	K
Contusion	41.45	41.83	24.99	30.43	18.41
Fracture	7.11	6.73	23.46	24.98	21.63
Laceration	16.67	16.69	15.63	7.69	25.23
Concussion	3.37	3.24	9.00	13.38	3.70
Rupture	0.14	0.08	2.60	2.44	2.80
Crush	0.04	0.00	1.67	1.03	2.44
Avulsion	0.72	0.70	1.57	2.01	1.04
Total Sever.	0.03	0.00	1.27	0.19	2.57
Puncture	0.20	0.19	0.80	1.30	0.20
Burn	0.06	0.05	0.51	0.00	1.13
Amputation	0.02	0.01	0.30	0.05	0.60
Dislocation	0.50	0.51	0.18	0.26	0.07
Other	0.02	0.02	0.04	0.06	0.02
Fract., Disl	0.14	0.14	0.01	0.03	.
Abrasion	14.28	14.61	0.00	.	0.00
Detachment	0.03	0.03	0.00	.	0.01
Sprain	1.91	1.95	.	.	.
Strain	11.32	11.58	.	.	.
Unknown	2.00	1.63	17.95	16.14	20.14

Table A-7. Distribution, in Percent, of Shown Populations of Injuries over Information Sources and Data Confidence Levels; Towaway Cars in NASS/CDS 1988-1995

A: All Injuries, 4,001,500 per Yr in the U.S.;
N: Noncompelling Injuries, 3,911,000 per Yr;
C: All Compelling Injuries, 90,500 per Yr;
S: Compelling Injuries of Survivors, 49,539 per Yr;
K: Compelling Injuries of Fatalities, 40,961 per Yr;

Information Source	A	N	C	S	K
Hosp w/o Emerg Recs	11.09	10.19	49.63	72.88	21.53
Autopsy w/o Hosp Recs	2.57	1.90	31.55	0.01	69.67
Emerg Recs Only	45.17	45.96	11.45	17.12	4.61
Interviewee	40.12	40.92	5.79	9.70	1.07
Lay Coroner	0.09	0.08	0.68	.	1.50
Private Physician	0.27	0.26	0.52	0.09	1.03
Police	0.38	0.38	0.26	0.17	0.36
EMS Personel	0.26	0.26	0.08	0.02	0.14
Other Unofficial	0.06	0.06	0.05	0.01	0.10

Confidence	A	N	C	S	K
Certain	57.50	57.68	49.51	52.41	45.90
Probable	31.29	31.16	37.17	35.12	39.74
Possible	11.21	11.16	13.31	12.47	14.36

Table A-8. Distribution, in Percent, of Shown Populations of Crash Involved Occupants over Sustained Number of Injuries per Occupant and Max Injury Severity;
Towaway Cars in NASS/CDS 1988-1995

A: All Crash Involved, 3,363,866 per Yr in the U.S.;
I: All Injured, 1,595,446 per Yr in the U.S.
N: Injured w Noncompelling Injury, 1,541,065 per Yr;
C: Injured w Compelling Injury, 54,381 per Yr;
S: Survivors w Compelling Injury, 34,672 per Yr;
K: Fatalities (by Definition Compelling), 19,750 per Yr;
U: Uninjured, 1,768,420 per Yr.

# of Injuries	A	I	N	C	S	K	U
0	54.78	0.02	.	0.58	.	1.69	99.80
1	15.19	33.44	34.46	7.11	5.96	9.30	0.17
2	10.77	23.85	24.47	7.76	8.00	7.29	0.02
3	6.90	15.28	15.52	9.09	9.32	8.65	0.00
4	4.65	10.30	10.35	9.24	11.40	5.12	0.00
5	2.69	5.96	5.88	7.96	9.83	4.38	0.00
6	1.81	4.02	3.86	8.16	9.89	4.84	.
7	1.04	2.31	2.10	7.54	8.52	5.69	.
8	0.67	1.49	1.30	6.40	6.92	5.41	.
9	0.40	0.88	0.68	6.06	7.08	4.11	.
10	0.30	0.67	0.49	5.29	5.84	4.25	.
11-20	0.72	1.59	0.87	20.27	16.38	27.68	.
21-Hi	0.08	0.18	0.01	4.54	0.85	11.58	.

MAIS	A	I	N	C	S	K	U
0	55.09	0.04	.	0.97	.	2.91	100
1	36.81	81.94	85.02	1.64	.	4.92	.
2	5.60	12.47	12.80	3.69	.	11.07	.
3	1.80	4.01	2.18	51.69	68.65	17.78	.
4	0.37	0.82	.	22.09	21.94	22.38	.
5	0.23	0.51	.	13.70	9.29	22.52	.
6	0.10	0.23	.	6.22	0.12	18.43	.

Table A-9. Distribution, in Percent, of Shown Populations of Crash Involved Occupants over Treatment Received and Medical Facility Used for Initial Treatment; Towaway Cars in NASS/CDS 1988-1995

A: All Crash Involved, 3,363,866 per Yr in the U.S.;
I: All Injured, 1,595,446 per Yr in the U.S.;
N: Injured w Noncompelling Injury, 1,541,065 per Yr;
C: Injured w Compelling Injury, 54,381 per Yr;
S: Survivors w Compelling Injury, 34,672 per Yr;
K: Fatalities (by Definition Compelling), 19,750 per Yr;
U: Uninjured, 1,768,420 per Yr.

Treatment	A	I	N	C	S	K	U
None	62.54	24.01	25.19	0.02	0.03	.	95.65
Dead	0.62	1.33	.	36.31	.	100	0.03
Hospital	5.10	10.90	9.02	58.92	92.50	.	0.13
X & Released	25.59	52.05	53.67	4.51	7.09	.	2.82
Other	6.15	11.71	12.12	0.24	0.38	.	1.37

Medical Facility	A	I	N	C	S	K	U
None	63.60	26.48	27.00	19.42	0.03	53.68	96.02
Trauma Center	13.88	28.43	27.60	48.28	61.35	25.19	1.18
Hospital	17.41	35.35	35.34	31.93	38.14	20.96	1.76
Clinic	0.20	0.39	0.40	0.12	0.10	0.16	0.04
Other	4.90	9.35	9.67	0.25	0.38	0.01	1.01

Table A-10. Distribution, in Percent, of Shown Populations of Crash Involved Occupants over Glasgow CS and Blood Given at Facility for Initial Treatment;
Towaway Cars in NASS/CDS 1988-1995

A: All Crash Involved, 3,363,866 per Yr in the U.S.;
I: All Injured, 1,595,446 per Yr in the U.S.;
N: Injured w Noncompelling Injury, 1,541,065 per Yr;
C: Injured w Compelling Injury, 54,381 per Yr;
S: Survivors w Compelling Injury, 34,672 per Yr;
K: Fatalities (by Definition Compelling), 19,750 per Yr;
U: Uninjured, 1,768,420 per Yr.

Glasgow CS	A	I	N	C	S	K	U
Not Injured	52.62	0.01	.	0.35	.	1.01	100
Not Treated	9.21	19.67	19.64	13.72	.	39.82	.
No Score	20.94	44.72	44.53	34.33	28.73	44.98	.
3 to 4	0.07	0.15	0.00	4.46	3.32	6.63	.
5 to 7	0.06	0.12	0.03	2.83	3.73	1.12	.
8 to 10	0.03	0.06	0.02	1.03	1.35	0.41	.
11 to 13	0.14	0.29	0.18	3.44	4.94	0.58	.
14-15	16.38	34.98	34.39	39.84	57.93	5.43	.
Unkn if Injured	0.55	0.00	1.20	0.00	.	0.01	.

Reconfigured Glasgow CS	A	I	N	C	S	K	U
3 to 4	0.42	0.42	0.00	8.64	4.65	46.76	.
5 to 7	0.34	0.34	0.07	5.49	5.23	7.91	.
8 to 10	0.16	0.16	0.07	1.99	1.90	2.89	.
11 to 13	0.82	0.82	0.52	6.67	6.93	4.13	.
14-15	98.26	98.26	99.34	77.22	81.28	38.32	.

Blood Given	A	I	N	C	S	K	U
No Blood Given	97.83	95.76	95.56	80.10	81.48	77.57	100
Blood Given	0.25	0.57	0.14	13.71	12.63	15.69	.
Unknown	1.92	3.67	4.30	6.19	5.89	6.74	.

Table A-11. Length of Hospitalization, Irrespective of Death, and Time to Death, Irrespective of Hospitalization
Towaway Cars in NASS/CDS 1988-1995

A: All Crash Involved, 3,363,866 per Yr in the U.S.;
I: All Injured, 1,595,446 per Yr in the U.S.;
N: Injured w Noncompelling Injury, 1,541,065 per Yr;
C: Injured w Compelling Injury, 54,381 per Yr;
S: Survivors w Compelling Injury, 34,672 per Yr;
K: Fatalities (by Definition Compelling), 19,750 per Yr;
U: Uninjured, 1,768,420 per Yr.

Occurrence & Length of Hospitalization	A	I	N	C	S	K	U
Not Hospitalized	95.33	89.96	91.87	38.01	8.30	86.17	99.88
1 to 5 Days	3.19	6.83	6.17	24.17	34.35	7.68	0.11
6 to 15	1.11	2.41	1.60	24.56	36.79	4.75	0.01
15 to 50	0.32	0.70	0.33	11.00	16.92	1.41	.
Over 50 Days	0.05	0.11	0.03	2.25	3.64	.	.

Reconfigured Length of Hospitalization	A	I	N	C	S	K	U
1 to 5 Days	68.35	68.04	75.96	39.00	37.46	55.51	91.63
6 to 15	23.75	23.96	19.69	39.62	40.12	34.30	7.98
15 to 50	6.86	6.95	4.00	17.75	18.45	10.19	0.38
Over 50 Days	1.04	1.05	0.34	3.63	3.97	.	.

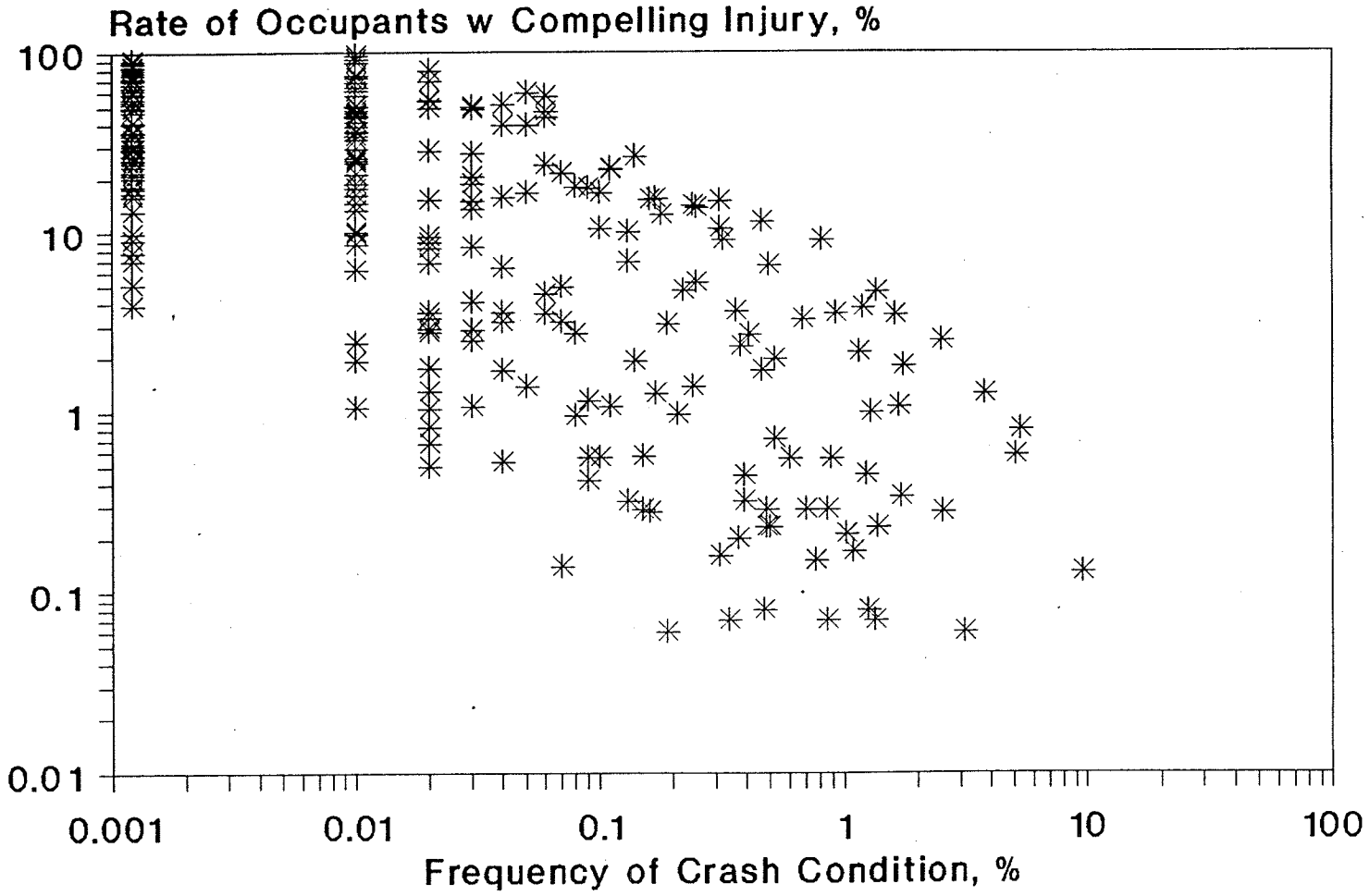
Time to Death	Percent
Within 1.5 Hrs	69.0
1.5 to 5.5	9.2
5.5 to 12.5	2.8
12.5 to 24	1.4
One to 5 Days	4.5
6 to 15 Days	7.0
16 to Hi	1.1
Unknown	5.1

Table A-12. Raw Data Sample Counts in NASS/CDS 1988-1995 for Towaway Car Occupants and Injuries

Compelling Injuries	Count	Percent	Cumulative Count	Cumulative Percent
No	173969	92.8	173969	92.8
Yes	13583	7.2	187552	100.0

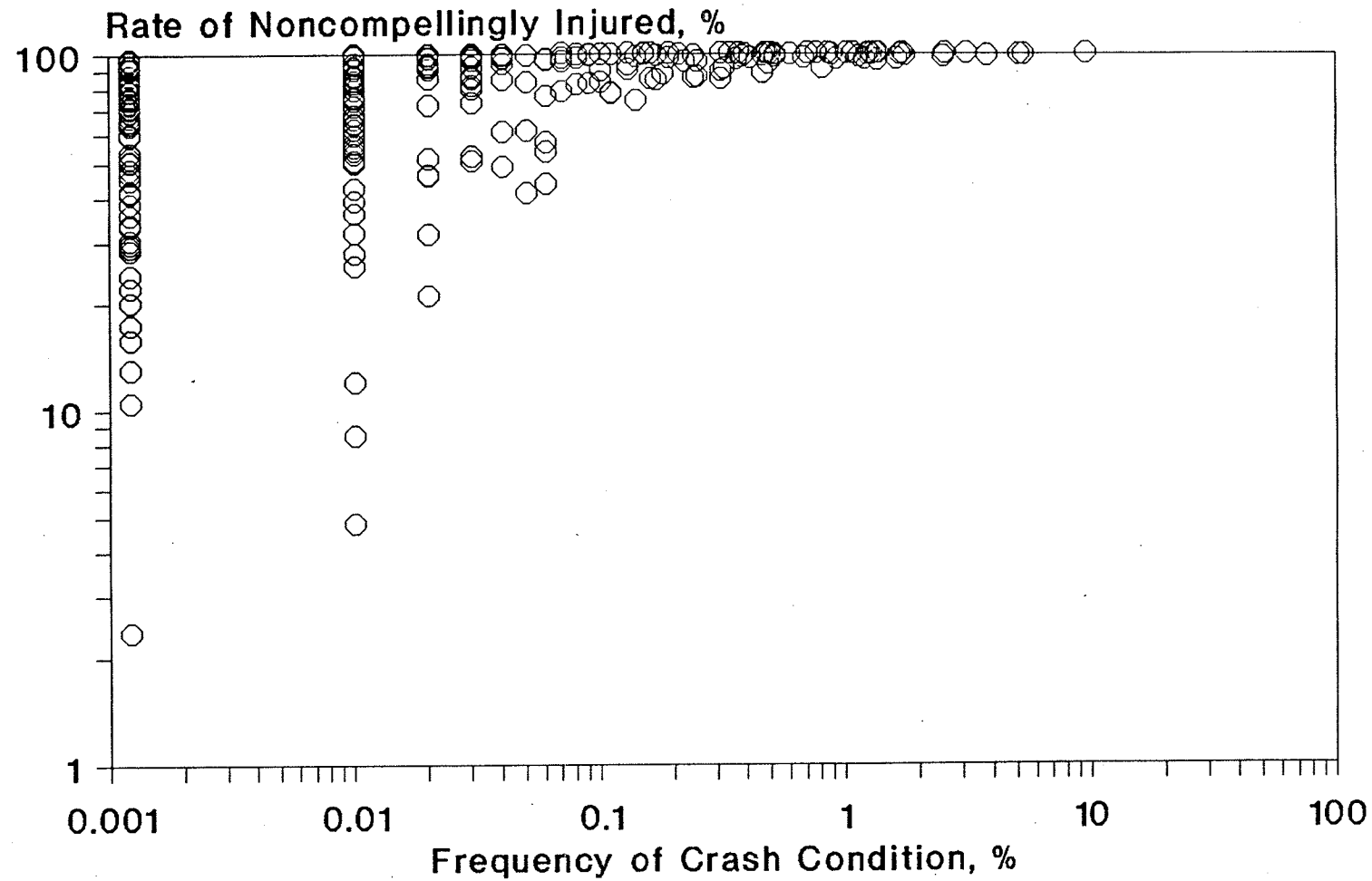
Occupants w Compelling Injuries	Count	Percent	Cumulative Count	Cumulative Percent
No	63938	91.3	63938	91.3
Yes	6068	8.7	70006	100.0

Fig. 1. Rate of Car Occupants with Compelling Injury, % of Crash Involved, versus Frequency of Crash Condition



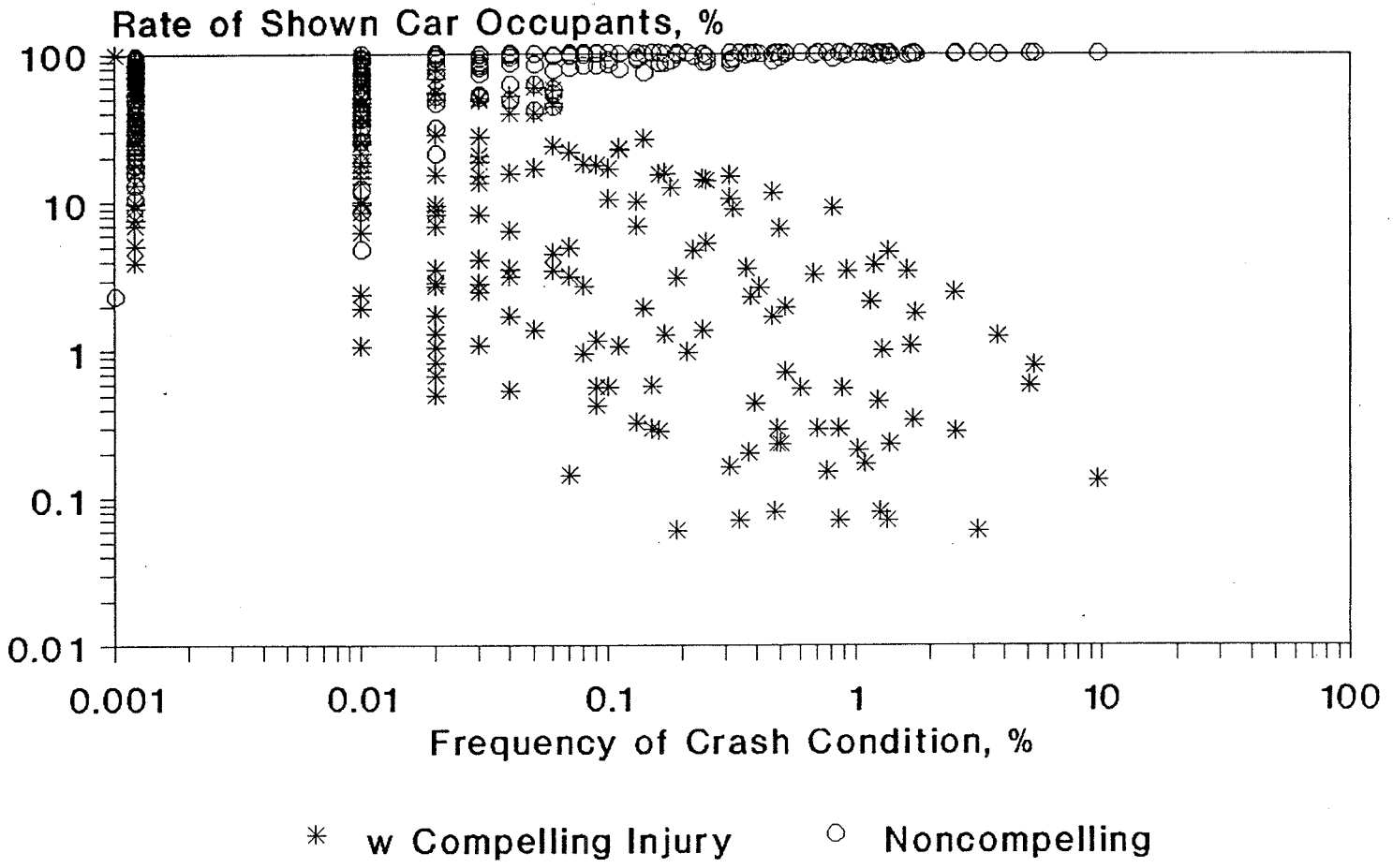
The NASS/CDS 1988-1995

Fig. 2. Rate of Occupants with Noncompelling Injury, as % of Crash Involved v. Frequency of Crash Condition



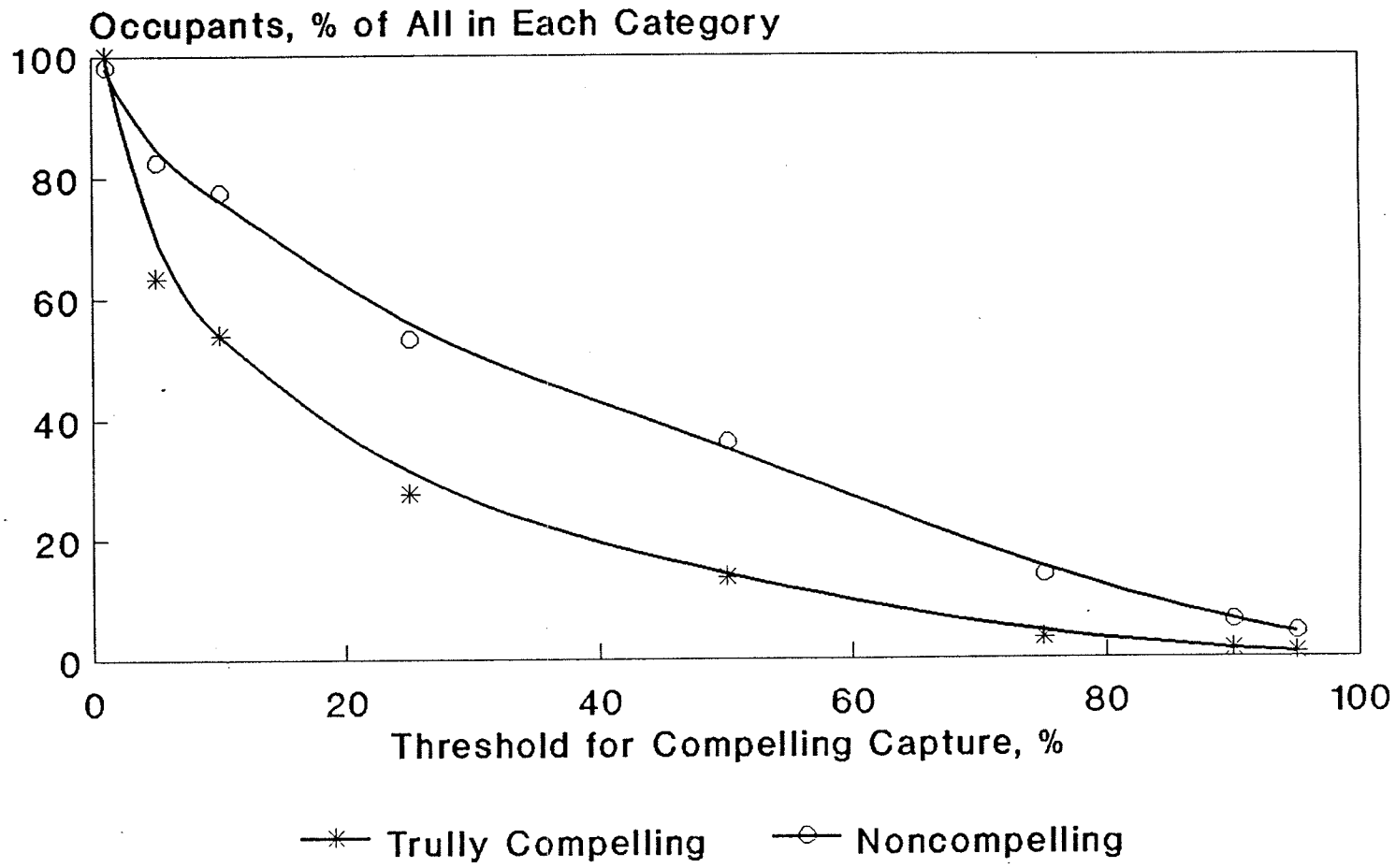
The NASS/CDS 1988-1995

Fig. 3. Rate of Occupants w Compelling or Noncompelling Injury, as % of Crash Involved v. Frequency of Crash Condition



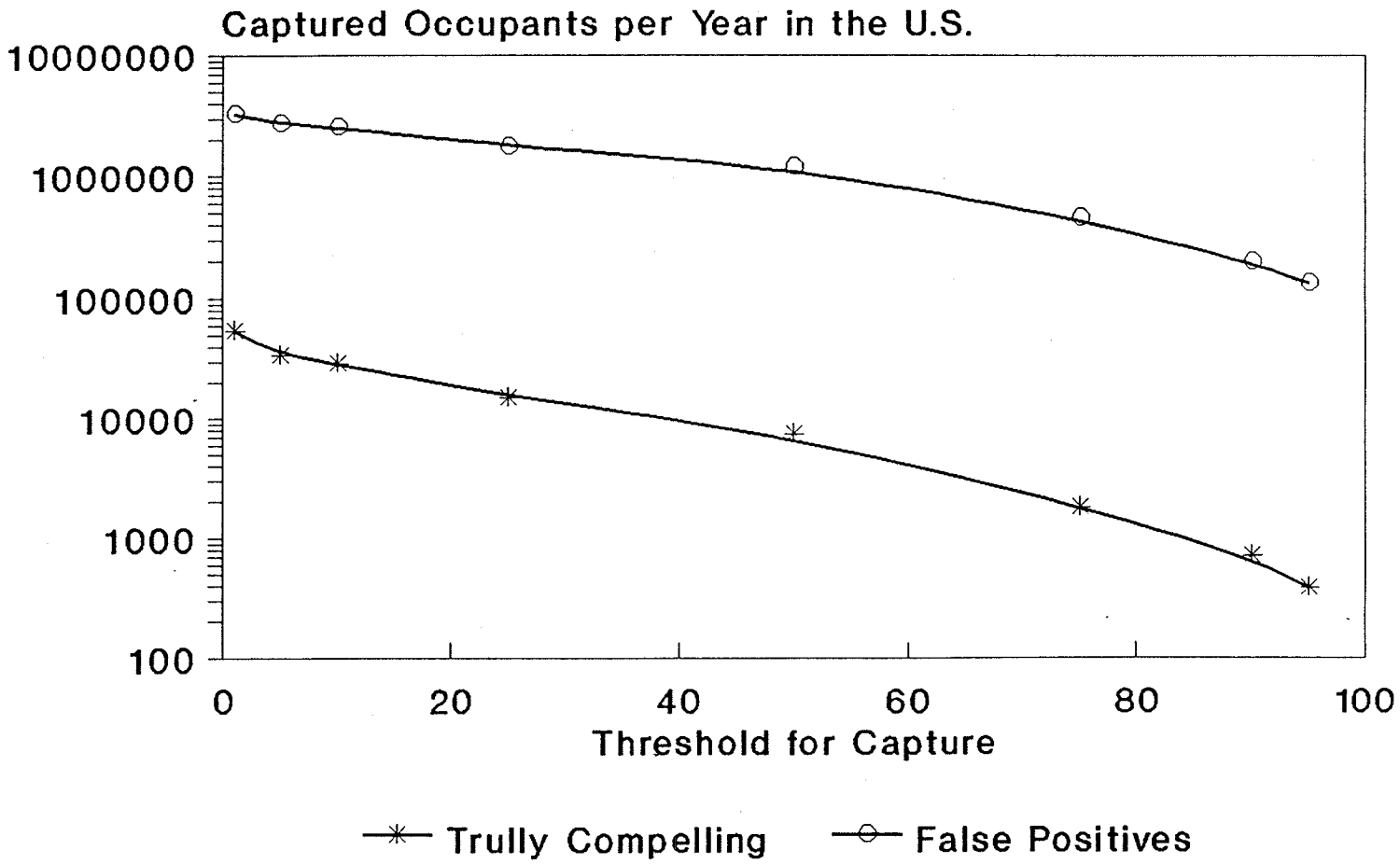
The NASS/CDS 1988-1995

Fig. 4. Captured Fraction of Occupants
w Compelling and False Compelling Injury
v. Threshold for Compelling Capture



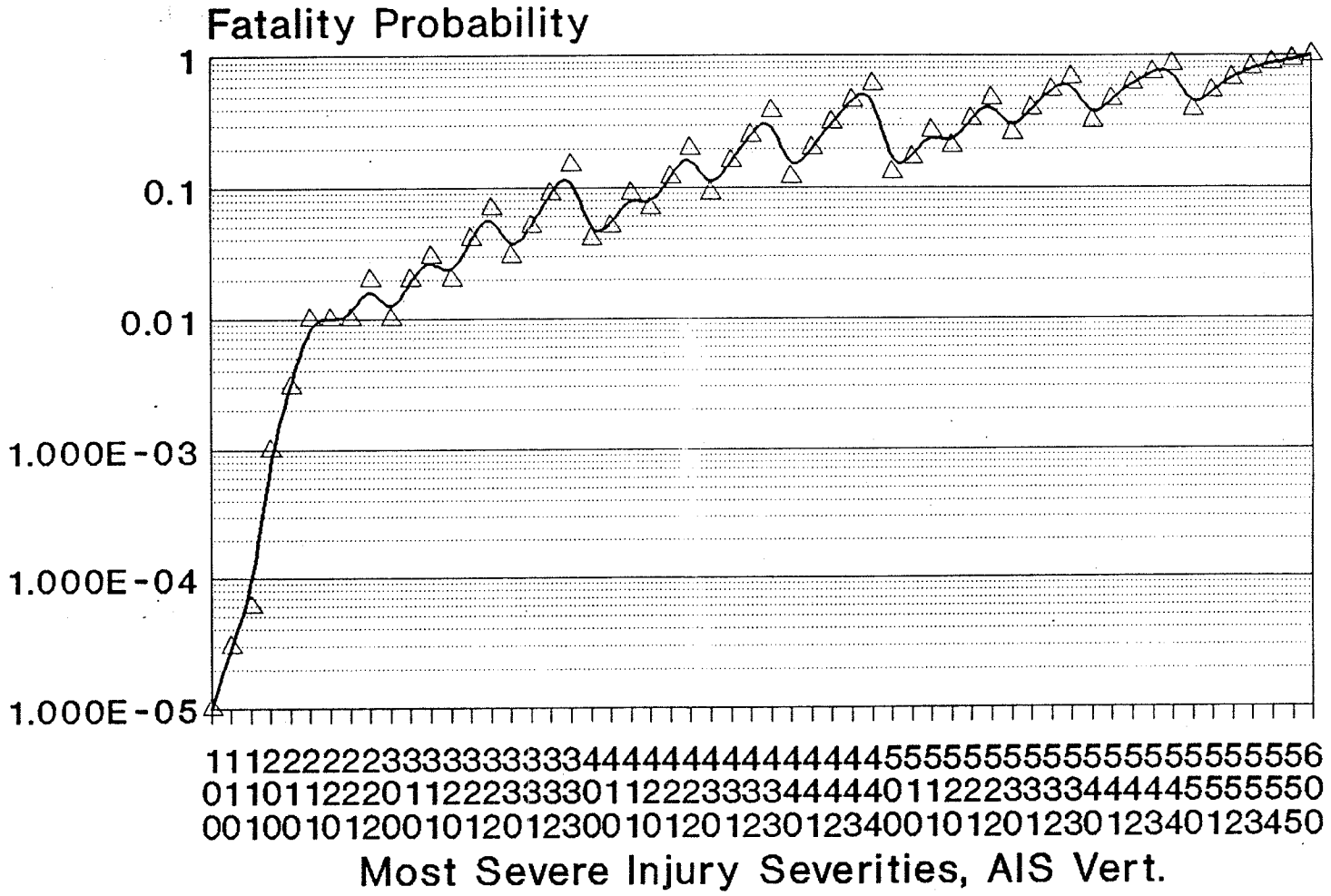
The NASS/CDS 1988-1995

Fig. 5. Captured Occupants w Compelling and Noncompelling Inj. (False Positives) v. Threshold for Compelling Capture



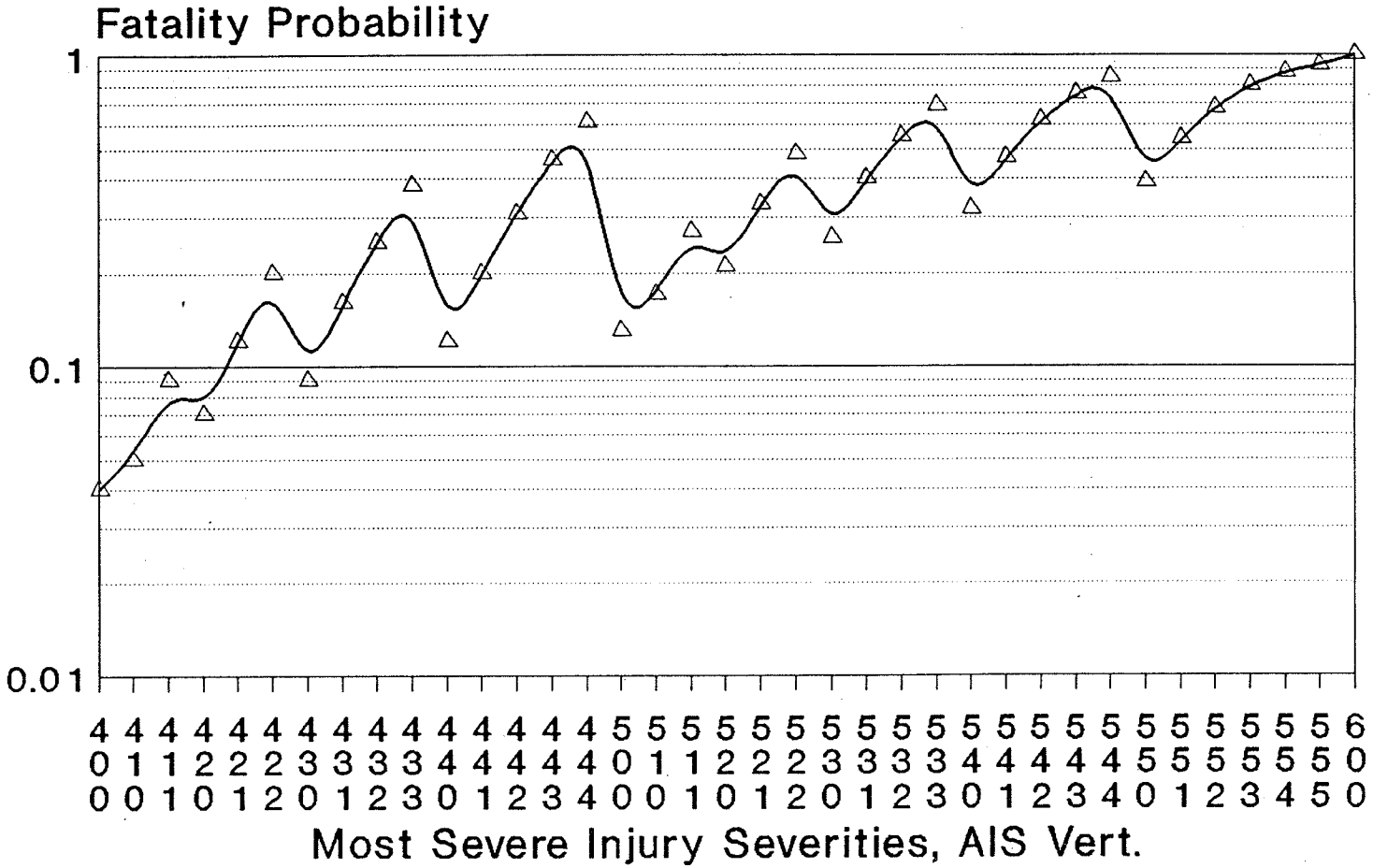
The NASS/CDS 1988-1995

Fig 6. Probability of Fatality versus
Severity of Three Most Severe Injuries



Logistic Regression Fit to NASS Data

Fig 7. Probability of Fatality versus
Severity of Three Most Severe Injuries;
Lowest Severity @ AIS=4



Logistic Regression Fit to NASS Data