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The Injury Severity Score Revisited

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The Injury Severity Score (5) (ISS) is a scalar (single number) measure of anatomic injury, widely used in and an important contribution to trauma research. The ISS is the sum of squares of the highest Abbreviated Injury Scale (1–3) (AIS) grade in each of the three most severely injured body regions. Thus the ISS is a summary measure of trauma to single or multiple body regions. Per cent mortality for blunt injured patients has been shown to be related to ISS (based on AIS–76) and patient age (4–6). Patients used to establish those relationships were treated in 1961 and 1967–1968. Similar relationships for penetrating injuries have not been prepared because, until the 1985 version, the AIS provided severity grades for blunt injuries only. The ISS is frequently used to assess or compare the injury severity of patient populations (7, 10, 13, 16) and as the anatomic component of trauma patient characterizations used in evaluation of care and quality assurance methods (8).

The AIS, first published in 1971, was developed to classify anatomic injury from motor vehicle-related trauma. It has been revised and broadened in scope in 1976, 1980, and 1985. Changes in injury coding, trauma care delivery, and clinical management mandate the updating of relationships between severity measures and mortality from which conclusions regarding patient management or healthcare policy issues may be drawn. The present study uses the most recent AIS version (AIS–85) to derive relationships between mortality rate and the ISS for contemporary patients with blunt or penetrating injuries and identifies important properties of the ISS which should be considered when the measure is used to compare case mix severity in different populations.

METHODS

The Database. Data for this analysis come from the Major Trauma Outcome Study (MTOS), an investigation of injury severity and patient outcome coordinated through the American College of Surgeons Committee on Trauma. MTOS began in 1982. Through 1986, 111 hospitals in the United States or Canada submitted data from more than 47,000 trauma patients. Forms for individual patients contain demographic and etiologic data as well as data describing patient physiology at injury scene, at hospital admission, and at 1 hour postadmission. Detailed written descriptions of injuries are provided, based on physician examination, computed tomography (CT) scans, X-rays, surgery, or autopsy. Forms are forwarded to a central data processing and analysis site in Washington, D.C. There, injury descriptions are coded into the ICD-9-CM (International Classification of Diseases, 9th Revision, Clinical Modification) (9), an injury taxonomy, and scored for severity using the 1980 and 1985 versions of the Abbreviated Injury Scale. Injury coding is performed by a small group of consistently trained, experienced coders in an attempt to reduce the significant variability which may be present in coding from numerous institutions (13). Data are subjected to human and computer checks for completeness, validity, and consistency. Injury Severity Scores are calculated by computer.

Data used in this analysis were submitted before 1986 and come from the 26 institutions reporting on consecutive trauma admissions and all patients dying from injury after entering the hospital doors. Data from 11,173 blunt-injured patients and from 3,703 patients with penetrating injuries were analyzed. Fifty patients with injury descriptions lacking the specificity necessary for injury coding (e.g., "cranio-cerebral trauma") were excluded after requests for injury clarification proved unsuccessful. Injuries for 82% of deaths were documented by CT scan, surgery, or autopsy. The remaining deaths, those without surgery, CT, or autopsy verification of injuries, had injury descriptions which were sufficiently specific for coding according to AIS-85 guidelines, e.g., gunshot wound to the head with entrance and exit sites, traumatic amputations, and fractured femurs.

Methods of Analysis. Injury Severity Scores are based on AIS–85. However, AIS severity scores for head injuries are assigned only for anatomic lesions, not for information on patient consciousness. While the latter is doubtless affected by injury severity, it can be affected by other factors such as the presence of drugs or alcohol, shock state, the administration of anesthetic agents, and other care provided. The inclusion of consciousness-related scores could therefore obscure institutional evaluations of care which are a major objective of MTOS.

For consistency with previous reporting, data were analyzed for two age categories, 0–49 years and ≥ 50 years, for blunt and for penetrating injury groups. For each patient subset (defined by injury type and age category), the number of patients and mortality rate were obtained for each ISS value. Mortality rates were also computed for the following ISS bins: 1–10, 11–20, . . . , 51–60 and 61–75. In plots of aggregated data, abscissas are averages of the ISS values within bins. Ninety-five per cent confidence limits about mortality rates use the normal approximation to the binomial distribution.

RESULTS

The numbers of patients with blunt and penetrating injuries, their respective mortality rates, average lengths of stay in hospital and intensive care unit (ICU), and average ages are given in Table I. The 5.8% mortality rate for blunt-injured patients is between those reported by Baker, 12.5% for 2,128 patients treated in 1968–1969

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(4, 5) and Bull, 4.9% for 1,333 road accident casualties treated in 1961 (6). The mortality rate for patients with penetrating injuries is 8.3%. Patients with blunt injuries had longer lengths of stay in hospital and in ICU than patients with penetrating injuries.

Cause of injury statistics (Table II) show that 53% of blunt-injured patients resulted from incidents involving motor vehicles or motorcycles. Twenty-four per cent of blunt injuries were due to falls. The average age for that group was significantly higher than for other causes of injury. The mortality rates for gunshot wounds (15.1%) and pedestrians (10.8%) are higher than for other groups.

Tables III–VI give the number of patients and the number and per cent of survivors and deaths for each ISS value, for each of the four patient subsets (blunt or penetrating injury, 0–49 years, and ⩾ 50 years). Figures 1 and 2 are plots of mortality rate vs. ISS bin for blunt injured patients in the two age categories. These plots contain contemporary values derived from MTOS data and results from Baker and Bull (4). Figure 3 gives MTOS mortality rates vs. ISS bins for penetrating injuries. Ninety-five per cent confidence intervals are given for observed MTOS mortality rates.

DISCUSSION

The ISS is based on the highest AIS score in each of the three most severely injured body regions (Table VII). AIS scores are integers from 1 to 6. Injuries with AIS scores of 1 or 2 are minor and rarely result in death. Injuries with AIS scores of 3, 4, and 5 are increasingly severe. AIS 6 injuries are considered to be incompatible with life. The AIS is not an interval scale: the increase in severity (mortality) from AIS 1 to 2 is much less than the increase from AIS 3 to 4 or 4 to 5.

Since its inception the AIS has provided severity scores only for blunt injuries. Data for penetrating injuries were made possible by their incorporation into the 1985 version of the Abbreviated Injury Scale. The AIS-85 manual contains the following caution regarding its treatment of penetrating injuries:

> "These [penetrating injury] descriptions are not sufficiently detailed to satisfy sophisticated studies of penetrating injury, but they do offer a uniformity for coding these injuries and a means to acquire some experience using the AIS in these situations."

Future AIS revisions are expected to contain more refined penetrating injury descriptions.

The ISS takes on integer values from 1 to 75. Patients with one or more AIS grade 6 injuries are automatically assigned the maximum ISS. If a patient's injuries are AIS grade 5 or less, the ISS is calculated as follows. AIS scores are sorted by ISS body region. Within regions, scores except the highest are disregarded. The three largest remaining AIS scores are squared, and the squares are summed to yield the ISS.

The average ISS, or distribution of ISS values, is frequently used to control for case mix in trauma patient populations for comparison of outcomes. The ISS is also used as the anatomic component of patient characterizations in evaluation of care, triage, and quality assurance. Ongoing nationwide data collection efforts make it possible to review the relationship of the ISS with survival. The data presented define contemporary ISS mortality rates for large samples of North American trauma patients treated between 1982 and 1985.

There is a temptation to compare current results for blunt injuries with those provided by Baker or Bull for patients treated in 1960's, but the two data sets are not strictly comparable. Injuries reported by Baker and Bull are coded in AIS-76 and MTOS injuries are coded in AIS-85. Factors discussed later also preclude comparisons that might allow statements concerning the results of changes in trauma are strategies over a 20-year period. Even if 1960's and 1980's mortality rates were based on the same version of the AIS, definitive comparisons would require more injury detail than is provided by the ISS.

Mortality rates in Figure 3 are not strictly increasing (or even nondecreasing) with ISS. Decreases in mortality rate are observed between ISS values of 20–30 and 30–40 for patients up to 50 years of age and between 30–40 and 40–50 for patients 50 years and older. However, confidence limits about observed mortality rates suggest that those changes may be due to sampling variation.

Nonmonotonic relationships between individual ISS values and mortality rates are seen in Tables III–VI. For example, Table II shows significant spikes in mortality rates for ISS values of 16 and 25 for blunt-injured patients. These spikes are not apparent in previous studies, perhaps because of data aggregation. Our explanation for such spikes provokes concern about the use of the ISS in applications with important consequences. Concern is primarily due to the diverse injury combinations which

TABLE I

Summary statistics: Data collected from consecutive admissions and all deaths by 26 institutions participating in MTOS

Injury Type	Sample Size	Survivors		Nonsurvivors		Average Hosp. Days	Average ICU Days	Average Age (yrs)
		Number	%	Number	%			
Blunt	11,195	10,542	94.2	653	5.8	10.2	5.3	35.3
Penetrating	3,714	3,405	91.7	309	8.3	6.9	3.5	30.7
Totals	14,909	13,947	93.5	962	6.5	9.4	4.9	34.2

TABLE II
Cause of injury data for consecutive admissions and all deaths by 26 institutions participating in MTOS

Cause of Injury	Sample Size	Survivors		Nonsurvivors		Average Hosp. Days	Average ICU Days	Average Age (yrs)
		Number	%	Number	%			
Motor vehicle	3,916	3,660	93.5	256	6.5	10.8	5.1	32.8
Motorcycle	961	885	92.1	76	7.9	12.5	5.7	26.1
Pedestrian	1,039	927	89.2	112	10.8	13.7	6.0	31.4
Gunshot wound	1,589	1,349	84.9	240	15.1	9.3	4.1	30.9
Stabbing	1,814	1,748	96.4	66	3.6	5.2	2.6	30.5
Fall	2,736	2,609	95.4	127	4.6	10.3	5.5	48.5
Other	2,830	2,746	97.0	84	3.0	6.5	4.9	30.0
Totals	14,885	13,924	93.5	961	6.5			

TABLE III
Patient outcome vs. ISS value: 26 MTOS institutions—Blunt injuries <50 years of age

ISS	Number Patients	Number Live	% Live	Number Die	% Die
1	1,017	1,014	99.7	3	0.3
2	156	156	100.0	0	0.0
3	11	11	100.0	0	0.0
4	1,418	1,413	99.6	5	0.4
5	975	973	99.8	2	0.2
6	100	100	100.0	0	0.0
8	325	323	99.4	2	0.6
9	1,373	1,344	97.9	29	2.1
10	643	635	98.8	8	1.2
11	46	46	100.0	0	0.0
12	95	95	100.0	0	0.0
13	323	315	97.5	8	2.5
14	265	262	98.9	3	1.1
16	224	192	85.7	32	14.3
17	325	296	91.1	29	8.9
18	107	99	92.5	8	7.5
19	70	68	97.1	2	2.9
20	87	74	85.1	13	14.9
21	76	69	90.8	7	9.2
22	133	122	91.7	11	8.3
24	71	66	93.0	5	7.0
25	159	115	72.3	44	27.7
26	86	66	76.7	20	23.3
27	60	51	85.0	9	15.0
29	117	96	82.1	21	17.9
30	15	13	86.7	2	13.3
32	11	9	81.8	2	18.2
33	25	17	68.0	8	32.0
34	100	71	71.0	29	29.0
35	21	13	61.9	8	38.1
36	19	11	57.9	8	42.1
38	27	18	66.7	9	33.3
41	41	24	58.5	17	41.5
42	5	3	60.0	2	40.0
43	20	11	55.0	9	45.0
45	16	7	43.8	9	56.3
48	5	0	0.0	5	100.0
50	21	11	52.4	10	47.6
51	2	1	50.0	1	50.0
54	3	0	0.0	3	100.0
57	4	0	0.0	4	100.0
59	4	2	50.0	2	50.0
66	1	0	0.0	1	100.0
75	27	2	7.4	25	92.6
All	8,629	8,214	95.2	415	4.8

TABLE IV
Patient outcome vs. ISS value: 26 MTOS Institutions—Blunt injuries ≥50 years of age

ISS	Number Patients	Number Live	% Live	Number Die	% Die
1	193	192	99.5	1	0.5
2	33	33	100.0	0	0.0
3	5	5	100.0	0	0.0
4	345	343	99.4	2	0.6
5	174	171	98.3	3	1.7
6	14	14	100.0	0	0.0
8	50	50	100.0	0	0.0
9	880	850	96.6	30	3.4
10	170	160	94.1	10	5.9
11	4	4	100.0	0	0.0
12	17	17	100.0	0	0.0
13	67	63	94.0	4	6.0
14	56	52	92.9	4	7.1
16	88	65	73.9	23	26.1
17	88	71	80.7	17	19.3
18	30	25	83.3	5	16.7
19	17	13	76.5	4	23.5
20	35	27	77.1	8	22.9
21	33	26	78.8	7	21.2
22	28	24	85.7	4	14.3
24	15	11	73.3	4	26.7
25	44	19	43.2	25	56.8
26	26	19	73.1	7	26.9
27	7	3	42.9	4	57.1
29	36	22	61.1	14	38.9
30	4	3	75.0	1	25.0
32	4	2	50.0	2	50.0
33	6	4	66.7	2	33.3
34	29	11	37.9	18	62.1
35	3	1	33.3	2	66.7
36	5	2	40.0	3	60.0
38	3	1	33.3	2	66.7
41	13	7	53.8	6	46.2
42	2	0	0.0	2	100.0
43	3	2	66.7	1	33.3
45	3	0	0.0	3	100.0
50	7	0	0.0	7	100.0
59	2	0	0.0	2	100.0
75	5	0	0.0	5	100.0
All	2,544	2,312	90.9	232	9.1

yield the same ISS value or values in a small ISS value neighborhood and which have substantially different mortality rates. The degree of injury heterogeneity present

TABLE V
Patient outcome vs. ISS value: 26 MTOS institutions—Penetrating injuries <50 years of age

ISS	Number Patients	Number Live	% Live	Number Die	% Die
1	609	608	99.8	1	0.2
2	15	15	100.0	0	0.0
4	813	811	99.8	2	0.2
5	79	79	100.0	0	0.0
8	107	106	99.1	1	0.9
9	537	524	97.6	13	2.4
10	116	115	99.1	1	0.9
11	2	2	100.0	0	0.0
13	120	117	97.5	3	2.5
14	9	8	88.9	1	11.1
16	301	274	91.0	27	9.0
17	53	51	96.2	2	3.8
18	31	29	93.5	2	6.5
19	7	7	100.0	0	0.0
20	56	52	92.9	4	7.1
21	5	5	100.0	0	0.0
22	12	12	100.0	0	0.0
24	4	4	100.0	0	0.0
25	316	198	62.7	118	37.3
26	38	29	76.3	9	23.7
27	1	1	100.0	0	0.0
29	54	44	81.5	10	18.5
30	5	3	60.0	2	40.0
32	16	11	68.8	5	31.3
33	3	2	66.7	1	33.3
34	45	36	80.0	9	20.0
35	3	2	66.7	1	33.3
36	1	1	100.0	0	0.0
38	12	9	75.0	3	25.0
41	13	7	53.8	6	46.2
42	4	0	0.0	4	100.0
43	3	3	100.0	0	0.0
45	2	1	50.0	1	50.0
50	11	6	54.5	5	45.5
51	1	0	0.0	1	100.0
54	1	0	0.0	1	100.0
75	19	2	10.5	17	89.5
All	3,424	3,174	92.7	250	7.3

TABLE VI
Patient outcome vs. ISS value: 26 MTOS institutions—Penetrating injuries ≥50 years of age

ISS	Number Patients	Number Live	% Live	Number Die	% Die
1	35	35	100.0	0	0.0
2	3	3	100.0	0	0.0
4	49	49	100.0	0	0.0
5	11	10	90.9	1	9.1
6	1	1	100.0	0	0.0
8	19	18	94.7	1	5.3
9	39	39	100.0	0	0.0
10	9	9	100.0	0	0.0
13	13	13	100.0	0	0.0
14	2	2	100.0	0	0.0
16	24	13	54.2	11	45.8
17	5	4	80.0	1	20.0
18	2	2	100.0	0	0.0
19	1	1	100.0	0	0.0
20	7	6	85.7	1	14.3
24	1	1	100.0	0	0.0
25	34	10	29.4	24	70.6
26	2	2	100.0	0	0.0
29	5	2	40.0	3	60.0
34	4	1	25.0	3	75.0
38	3	1	33.3	2	66.7
41	2	0	0.0	2	100.0
45	3	2	66.7	1	33.3
54	1	1	100.0	0	0.0
66	1	0	0.0	1	100.0
75	3	0	0.0	3	100.0
All	279	225	80.6	54	19.4

in some ISS cohorts does not provide a reliable basis for estimating outcomes (e.g., mortality rates), inflates the variability of outcome estimates, and obscures comparisons of patient populations.

These concerns are illustrated in the following examples wherein the three AIS scores (1 or 2 of which may be zero) used in the computation of the ISS are displayed in nonincreasing order. For example, the "triple" (14) of AIS scores (4,3,1) yields an ISS of 26 ($4^2 + 3^2 + 1^2 = 26$) and the triple of (4,1,0) gives an ISS of 17. These triples, the basis for ISS computations, contain no body region information. Thus the ISS gives equal importance to all body regions.

Table VIII gives the numbers of patients in each patient subgroup of the ISS = 14 through ISS = 19 cohorts for patients less than 50 years of age with blunt injuries. ISS values of 14 and 16 can result only from the triples (3,2,1) and (4,0,0), respectively. An ISS of 15 cannot occur. The precipitous increase in mortality rate from ISS = 14 (1.1%) to ISS = 16 (14.3%) is likely due to the seminal presence of AIS 4 injuries in the latter cohort and the noninterval nature of the AIS. The mortality rate for ISS = 17 is 8.9%, substantially less than that for ISS = 16. However, an ISS of 17 can result from two triples: (4,1,0) and (3,2,2). The difference in mortality rates for the two subsets of the ISS = 17 cohort is substantial. Thus, the decline in mortality rate between the ISS values of 16 and 17 is credible, likely resulting from the heterogeneous patient groups which comprise the ISS = 17 cohort. The difference in mortality rates between the two subgroups of the ISS = 18 cohort is small, and we believe, due to the small sample size for the (4,1,1) patient subgroup. Note that the ISS = 19 cohort has a low mortality rate and that it cannot include patients with AIS grade 4 injuries.

Thus patient mortality rates from two institutions within even a single ISS value cohort, say 17, are not directly comparable unless the relative proportions of patients with (4,1,0) and (3,2,2) injuries are known.

Another source of ISS cohort heterogeneity is illustrated for ISS = 16: (4,0,0) is the only triple which produces an ISS of 16. The AIS 4 injury can occur in any ISS body region. Table IX, which gives mortality rate by body region injured for patients with ISS = 16, shows that head injuries have a higher mortality than injuries to other body regions. Thus, even within ISS cohorts comprised of a single injury triple, there may be significant patient severity heterogeneity.

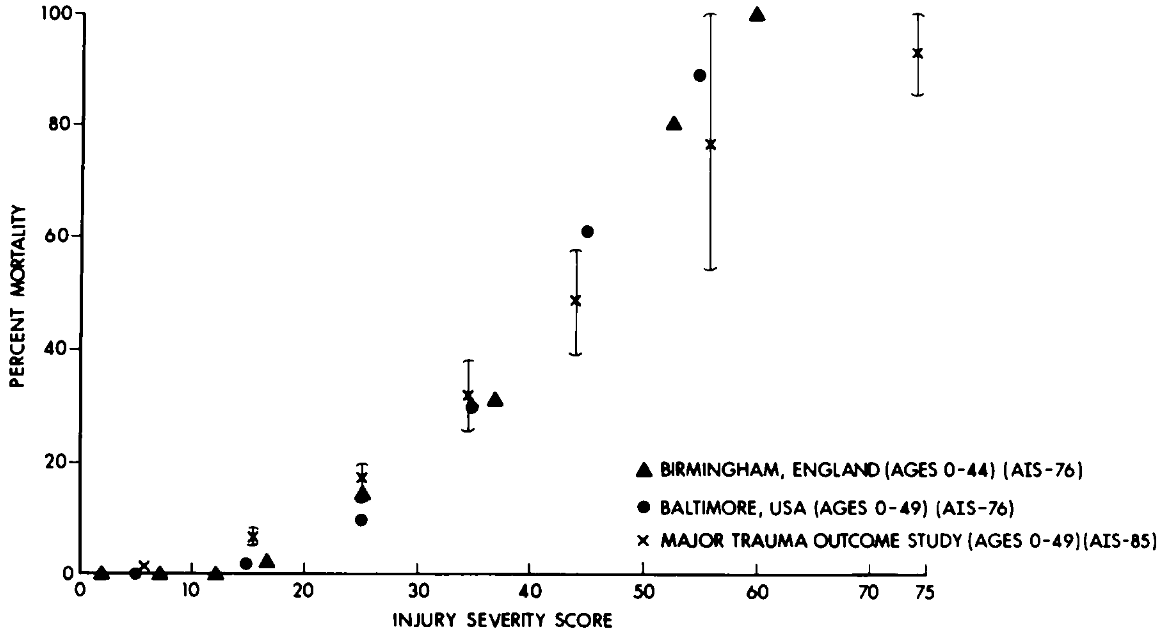

Figure 1. Mortality Rate vs ISS Interval
BLUNT INJURED PATIENTS<50 YEARS OF AGE

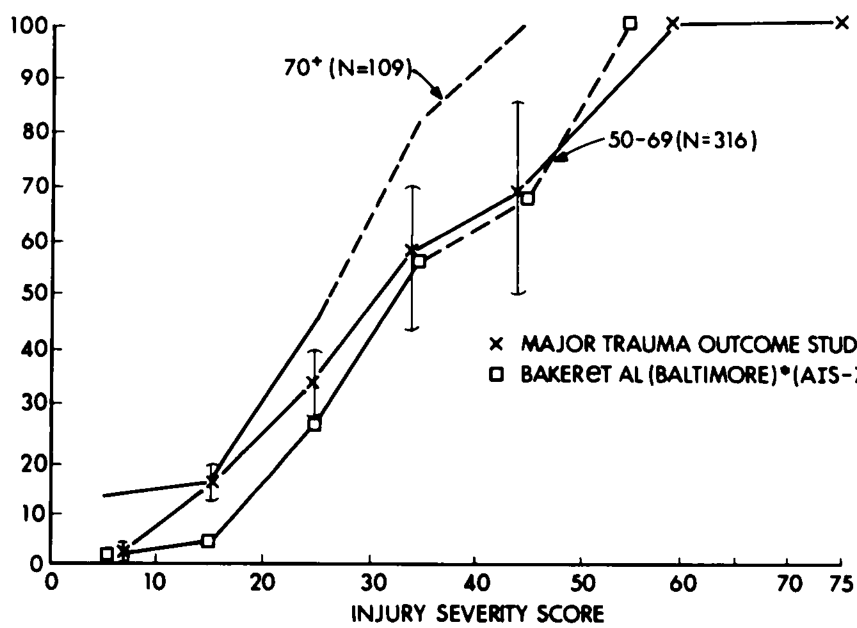

Figure 2. Mortality Rate vs ISS Interval
BLUNT INJURED PATIENTS≥50 YEARS OF AGE

*DOA's EXCLUDED FROM BALTIMORE DATA

Still another source of heterogeneity is suggested. Many hospitals, including the authors', conducted a peer review of patients identified in the September 1985 MTOS analysis as "unexpected deaths." These patients died and had estimated survival probabilities exceeding 0.5. Most had multiple, serious (AIS 4 and 5) injuries within a single body region, clinically judged to make survival unlikely. Yet the ISS, by definition, excludes all but the most severe injury in any body region. Thus patients with only one injury, an AIS 5 injury to the abdomen, and those with two, three, or even more AIS 5 injuries to the abdomen only are included in the ISS 25 cohort, thereby increasing heterogeneity.

Figures 1–3 display 95% confidence intervals about observed MTOS mortality rates for the ISS bins considered. In the determination of those intervals, the mor-

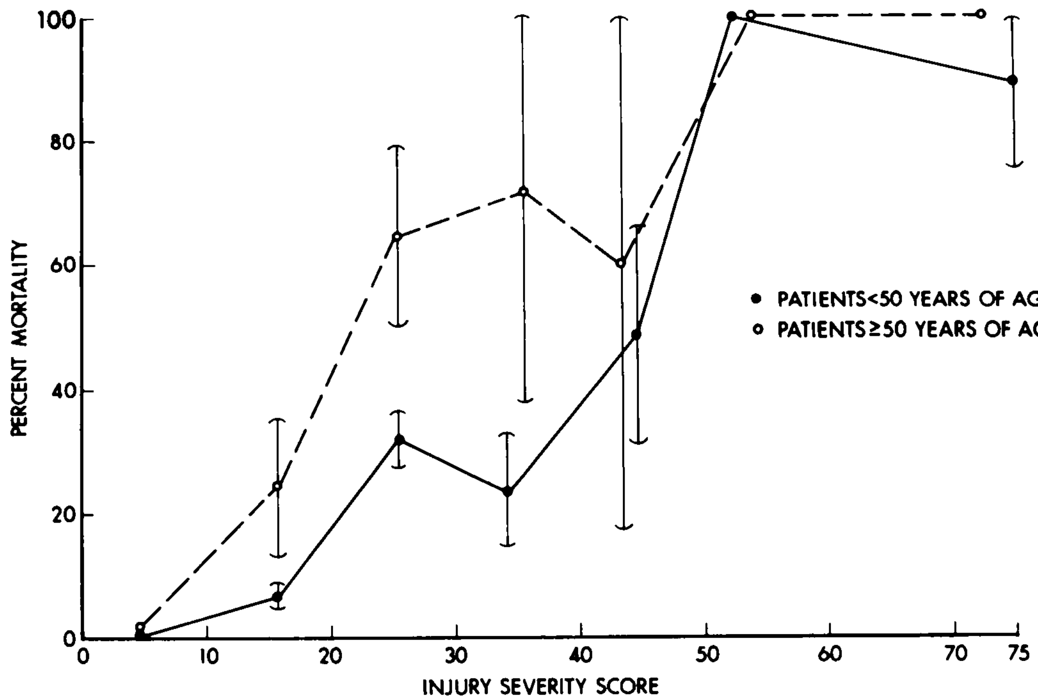

Figure 3. MTOS Mortality Rate vs ISS.
PENETRATING INJURED PATIENTS

TABLE VII
ISS body regions

Number	Body Region(s)
1	Head & neck
2	Face
3	Thorax
4	Abdomen
5	Extremities
6	External

TABLE VIII
Patient subgroups within ISS cohorts 14–19

ISS Value	AIS Score Triple	Sample Size	% Mortality
14	(3, 2, 1)	265	1.1
16	(4, 0, 0)	224	14.3
17	(4, 1, 0)	133	18.1
	(3, 2, 2)	192	2.6
18	(3, 3, 0)	92	7.6
	(4, 1, 1)	15	6.7
19	(3, 3, 1)	70	6.8

tality rate for an ISS bin is treated as an estimate of a binomial distribution parameter. One assumption of the binomial model is that such an estimate is based on the outcomes of similarly injured patients, each with the same survival probability. That assumption is rarely fulfilled in real-world situations. Differences in patient physiologic condition or chronic health status affect likelihood of survival. In this application, the assumption's validity is further undermined by the presence of distinct

TABLE IX
Outcomes for patient subgroups of ISS 16 cohort

Body Region of AIS 4 Injury	Number of Patients	% Mortality
Head & neck	163	17.2
Face	3	0.0
Thorax	33	6.1
Abdomen	19	10.5
Extremities	6	0.0

AIS triples with substantially different mortality rates within ISS value or bin cohorts. Thus the confidence intervals provided should be viewed as coarse approximations only.

Comparisons of mortality, morbidity, or disability rates that use the ISS to control for case mix must be viewed with caution because of limitations inherent in the Injury Severity Score. Nonetheless, the ISS remains the most widely used measure of anatomic injury severity. As such, the contemporary relationships presented here between ISS and mortality rate may be of use to injury researchers as a means to roughly categorize severity mix. Figures 4 and 5 present ISS vs. mortality rates for contemporary patients with blunt or penetrating injuries. In these plots, data are aggregated over the ISS bins defined in Table X. We believe that those bins may help mitigate the effect of heterogeneity between ISS value cohorts. Heterogeneity within cohorts remains unaffected.

We believe that the described limitations of the ISS

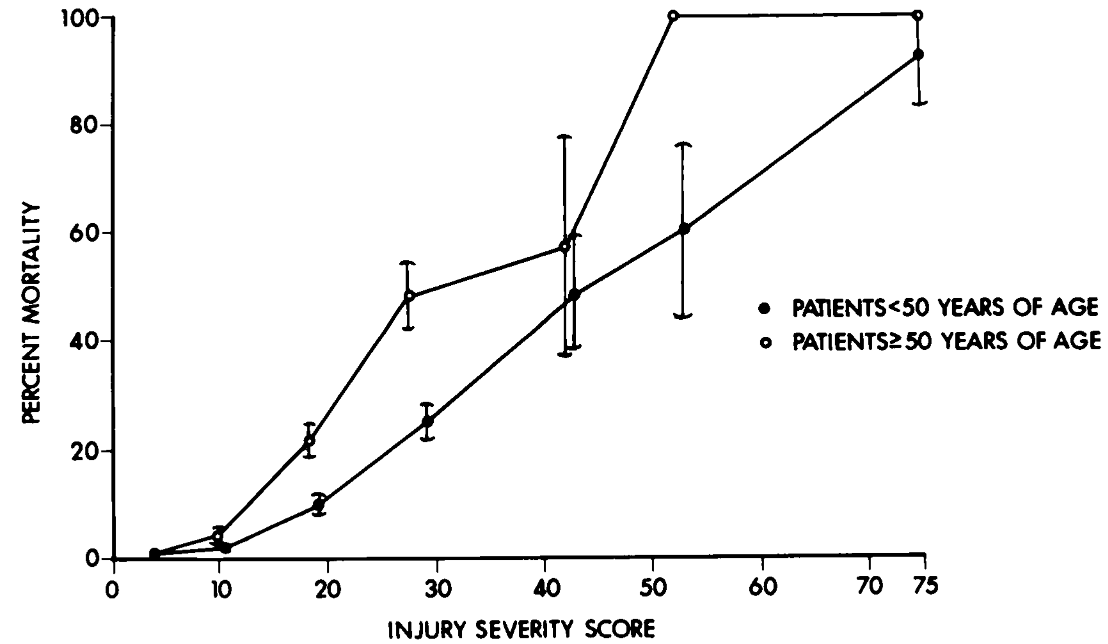

Figure 4. MTOS Mortality Rate vs ISS For Proposed Intervals.
BLUNT INJURED PATIENTS

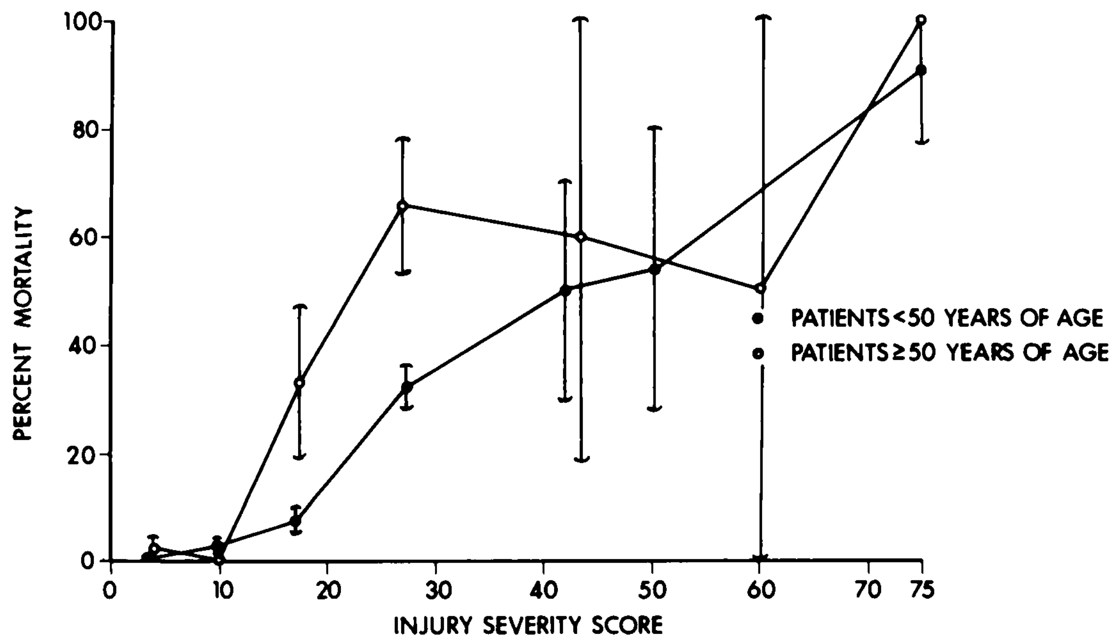

Figure 5. MTOS Mortality Rate vs ISS For Proposed Intervals.
PENETRATING INJURED PATIENTS

result from the use of a one-dimensional score to summarize the effects of multiple anatomic injuries. The exclusion of all but the most severe injury in any body region, the diversity of injury severity combinations and injury locations which produce the same ISS value, and the equal weighting given each body region all contribute to the heterogeneity of ISS value or interval cohorts. The Joint Commission on the Accreditation of Hospitals has announced its intention to consider patient outcome in its deliberations (14). States are establishing formal trauma center accreditation and review procedures (15) and the American College of Surgeons Committee on Trauma is planning an added emphasis on outcome-related peer review quality assurance activities. The American Society for Testing Materials has made recommendations that would base payment for trauma care

TABLE X
Proposed ISS value intervals

ISS Interval	Rationale: Most Severe Injury/Combination Included
1-8	AIS 2
9-15	AIS 3
16-24	AIS 4
25-40	AIS 5 but not AIS 5 and AIS 4
41-49	AIS 4 and AIS 5
50-66	Two AIS 5's and one AIS 4
75	AIS 6's and 3 AIS 5 injuries

on injury severity. In such important applications increased precision must be required of the measures used to characterize trauma patients. A multidimensional characterization which considers the number, location, and severity of anatomic injuries is required.

Any revised characterization of injury will doubtless be based on the AIS and/or ICD-CM. Trauma registries and data banks should continue to store anatomic injury information coded in both systems. A computerized mapping from ICD-9-CM to AIS-85 has been developed by Johns Hopkins University researchers (12). Injuries coded in those schemes will be usable by the mathematical construct chosen to replace or modify the ISS.

Acknowledgments

The authors wish to acknowledge the institutions and individuals participating in the American College of Surgeons Committee on Trauma-sponsored Major Trauma Outcome Study (MTOS). Data collected by those institutions are the basis for this paper. Participating institutions and local physician Project Directors are listed in the *Appendix*. Without their efforts, neither this study nor MTOS could be conducted.

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APPENDIX

Hospital	*Local Project Director*
St. Louis City Hospital St. Louis, MO	Ray M. Keltner, Jr., M.D.
Ben Taub General Hospital Houston, TX	Kenneth L. Mattox, M.D.
Charity Hospital Tulane University School of Medicine New Orleans, LA	Norman E. McSwain, Jr., M.D.
Regional Medical Center of Memphis Presley Trauma Center Memphis, TN	James W. Pate, M.D.
New Britain General Hospital New Britain, CT	Gerald O. Strauch, M.D.
San Francisco General Hospital San Francisco, CA	Donald D. Trunkey, M.D.
University of Iowa Hospital & Clinics Iowa City, IA	Luis F. Urdaneta, M.D.
University of Massachusetts Hospital Worcester, MA	Wayne E. Silva, M.D.
Children's Hospital National Medical Center Washington, D.C.	Martin Eichelberger, M.D.
University of Connecticut Hospital Farmington, CT	Philip A. Stent, M.D.
Plains Health Centre Regina, Saskatchewan	Robert Cameron, M.D.
West Virginia University Medical Center Morgantown, W. VA	Thomas Vargish, M.D.
St. Paul-Ramsey Medical Center St. Paul, MN	Richard Strate, M.D.
Parkland Memorial Hospital Dallas, Texas	Erwin R. Thal, M.D.
University of Michigan Medical Center Ann Arbor, MI	James R. Mackenzie, M.D.
Hurley Hospital Flint, MI	Same as above
St. Francis Hospital & Medical Center Hartford, CT	Donald R. Becker, M.D.
Fairfax Hospital Fairfax, VA	Michael C. Potter, M.D.
Grossmont District Hospital East San Diego County Regional Medical Center San Diego, CA	Paul LoCascio, M.D.
Jefferson University Hospital Philadelphia, PA	Jerry Verick, M.D.
Polyclinic Medical Center Harrisburg, PA	J. Stanley Smith Jr., M.D.
Lincoln Hospital Mental Health Center NYC Health & Hospital Corporation New York, NY	Alexander Kuehl, M.D.
Bronx Municipal Hospital Center New York, NY	Same as above
University of Pennsylvania Hospital Philadelphia, PA	Sheldon Jacobson, M.D.
University of Missouri Medical Center Columbia, MO	Frank L. Mitchell, M.D.
Harlem Hospital New York, NY	Barbara Barlow, M.D. Margarite Silvera, M.D.
University of Chicago Wyler Children's Hospital Chicago, IL	Dennis Shermeta, M.D.
The Hospital for Sick Children Toronto, Ontario	David E. Wesson, M.D.
Memorial Hospital Medical Center Earl & Lorraine Children's Hospital of Long Beach, CA	Morris J. Asch, M.D. John Sweeney, M.D.
San Juan Regional Medical Center Farmington, NM	George Pfaltzgraff, M.D.

University of New Mexico Hospital Albuquerque, NM	Gerald Demarest, M.D.
Cook County Hospital University of Illinois Hospital Chicago, IL	Hernan M. Reyes, M.D.
Elliot Hospital Manchester, NH	Samuel C. May, M.D.
University Hospital Jacksonville, FL	Clayton Shatney, M.D.
The Children's Hospital Denver, CO	David P. Meagher, Jr., M.D.
Mercy Hospital & Medical Center San Diego, CA	Anne Huehn, R.N.
John C. Lincoln Hospital Phoenix, AZ	Ms. Betty Barker
Portland Adventist Medical Center Portland, OR	Richard H. Cales, M.D.
Miami Valley Hospital Dayton, OH	Larry M. Jones, M.D.
St. Louis University Medical Center St. Louis, MO	Joseph C. Stothert, Jr., M.D.
Johns Hopkins Hospital Baltimore, MD	J. Alex Haller, Jr., M.D.
Iowa Methodist Medical Center Des Moines, IA	David T. Sidney, M.D.
Roanoke Memorial Hospital Roanoke, VA	Robert E. Berry, M.D.
St. Luke's Hospital Fargo, ND	Brent E. Krantz, M.D.
Memorial Medical Center Savannah, GA	Ginger Carlisle, R.N.
St. Joseph's Hospital & Medical Center Phoenix, AZ	William Schiller, M.D.
St. Anthony's Hospital Rockford, IL	James W. Girardy, M.D.
Kiwanis Pediatric Trauma Institute of the N. E. Medical Center Boston, MA	Richard Murphy, M.D.
Ohio State University Hospitals Columbus, OH	Kenneth Kudsk, M.D.
Scottsdale Memorial Hospital Scottsdale, AZ	Gail Nicoll, R.N.
Pioneer Memorial Hospital Prineville, OR	Ronald Sproat, M.D.
Vanderbilt University Hospital & Medical Center Nashville, TN	John A. Morris, M.D.
University of Hawaii Queen's Medical Center Honolulu, HI	Peter Halford, M.D., F.A.C.S.
Life Flight Trauma Services Grant Medical Center Columbus, OH	Thomas Bayter, M.D.
Deaconess Medical Center Spokane, WA	Bruce E. Johnson, M.D.