Incidence, Causes and Severity of Injuries in Aquitaine, France: A Community-Based Study of Hospital Admissions and Deaths

L. Tiret, PhD, B. Garros, MS, P. Maurette, MD, V. Nicaud, MS, M. Thicoipe, MD, F. Hatton, MD, and P. Erny, MD

Abstract: This paper reports the results of a study of injuries conducted during a one-year period within a defined geographic population of 2.7 million persons (Aquitaine, France). Cases were defined as unintentional or intentional injuries, either resulting in immediate death before reaching hospital or requiring hospital admission. During the one-year period, 1,181 deaths were registered and 8,190 hospital admissions occurred during the sample periods. The three leading causes of injury were falls (40 per cent), traffic accidents (27 per cent), and poisonings (15 per cent). The overall incidence of injuries was 136 per 10,000 person years. Incidence by sex and age was assessed for the main external causes. The ratios of nonfatal to fatal cases were calculated by sex and age and by external cause. The origin of the injury was suicide in 14 per cent of cases and assault or homicide in 3 per cent. The severity of injuries, assessed using an automatic computation of the Injury Severity Score (ISS), ranged from 1 to 66 with a mean of 6.9. Substantial variations of ISS were observed according to external cause. At the 8th day following admission, 31 per cent of hospital-treated patients were still hospitalized and 0.8 per cent had died in hospital. The outcome correlated well with the ISS. (*Am J Public Health* 1989; 79:316–321.)

Introduction

Injuries constitute a major health problem in all developed countries and in an increasing number of developing countries. They have been examined by mortality data[1,2] or by morbidity data focusing either on the pediatric population[3–7] or on specific injury types, such as head traumas,[8,9] burns,[6,10] or motor vehicle injuries.[7,11] Very few studies describe the nature of the problem as a whole within an entire population. In some countries, routine statistics[12,13] or permanent surveys, such as the National Health Interview Survey in United States,[14] provide annual estimates of the incidence of injuries but without great detail. More information was gathered by the Northeastern Ohio Trauma Study,[15,16] carried out in 1977 in the United States. However, that study did not include fatal cases and did not provide an evaluation of the severity of injuries.

This paper reports the first results of an epidemiological study of injuries conducted during 1986 among a defined geographic population in France. Its aims were to provide estimates of the incidence of fatal and nonfatal cases of injury, to describe their external causes, and to assess the severity of injuries using the Injury Severity Score (ISS) derived from the Abbreviated Injury Scale (AIS),[17] the most widely used score for rating severity of multiple injuries.[18–21]

Methods

The study was carried out prospectively over a one-year period in the Aquitaine, one of the 22 administrative regions of France. This region contains both urban and rural areas; its main city is Bordeaux. It is bordered by the western Atlantic coastline and the southern mountain range of Pyrénées. Extrapolating from the 1982 census, the 1986 population was estimated to be 2.7 million persons (4.9 per cent of the whole population of France), of which 16 per cent were over 65 years of age. The study was based on an administrative region since in the French health care system, each region constitutes an independent entity and people normally receive medical care in their region of residence. The presence of a referral teaching hospital in the region reduces the possibility of transfer for specialized treatment outside the region.

Case Definition

Cases were defined as those injuries sustained in Aquitaine between December 1985 and December 1986, either resulting in immediate death before reaching hospital, or requiring hospital admission in a private or public institution of the region. Injuries to residents and non-residents of the region were both recorded but the latter were excluded from the data reported here. The field of study included both unintentional and intentional injury cases (the latter including homicides, assaults, suicides, and self-destructive actions). Surgical and medical misadventures (corresponding to codes E870–E879 and E930–E949 of the International Classification of Diseases—9th revision[22]) and late effects of accidental injury (E929) were excluded.

Data Collection

All public and private hospitals regularly involved in the treatment of injuries, because of their geographical position or the presence of a trauma specialist, were included in the study. Among other hospitals, one out of two was randomly selected. In each institution, the survey lasted 13 weeks spread over the whole year:

- the teaching hospital was investigated every fourth week;
- non-teaching and private hospitals of the first category were divided into four groups, each being investigated during three periods (4 weeks, 4 weeks, and 5 weeks). The survey was initiated successively in each group with an interval of four weeks, the whole year therefore being covered by the study;
- private hospitals of the second (non-trauma) category were divided into two groups, each being successively investigated during a 13-week period.

This scheme provided a sample representative by time of day, day of the week, and season.

Address reprint request to L. Tiret, PhD, Institut National de la Santé et de la Recherche Médicale (INSERM), Unité 164 16, Avenue Paul Vaillant-Couturier, 94807 VILLEJUIF CEDEX-France. Co-author Nicaud and Dr. Hatton are also affiliated with INSERM; Garros is with Observatoire Régional de la Santé d'Aquitaine 58, Rue de Marseille, 33000 Bordeaux, France; Drs. Maurette, Thicoipe, and Erny are with the Département d'Anesthésie-Réanimation—Centre Hospitalier Régional Place Amélie Raba Léon, 33076 Bordeaux Cedex, France. This paper, submitted to the Journal May 10, 1988, was revised and accepted for publication September 22, 1988.

Injury cases resulting in death before reaching hospital were recorded from death certificates. All cases registered in the region during the one-year period were included, except for those having been registered in a hospital or a clinic.

Data Collected

For each injury case requiring hospital admission, the medical staff of the institution completed a questionnaire within the first 24 hours following admission. Data collected concerned the demographic characteristics, time and place of injury, origin, cause and clinical nature of injury. Causes of injury and poisoning were coded into 14 specific categories. Cases with two or more possible causes were coded according to the primary harmful event. Outcome within eight days of injury was added later. The clinical nature of traumatic injuries was coded according to a classification specially devised for this study by a multidisciplinary workgroup, including trauma specialists and epidemiologists. The purpose of this classification was to provide an automatic computation of the ISS. The descriptive lesions, taken directly from the AIS-80 manual,[17] were condensed into 200 codes being organized within the six body regions defined for the ISS. A defined injury code corresponded either to one specific lesion or to a group of several lesions of a same anatomic site and having an identical AIS severity level. The person in charge of completing the questionnaire simply had to circle the codes relative to all injuries sustained, then an AIS grade was automatically assigned to each injury code by a computer algorithm and the ISS was computed.*

A test to control the adequacy of ratings by this method was undertaken on 164 patients treated in an emergency department. One physician computed the ISS using the manual. The same lesions were then coded in the questionnaire and the ISS was derived by the algorithm. In 14 per cent of cases, there were slight discrepancies between the two ratings, due to the adaptation, which over-simplified some categories of lesions in the AIS, such as spinal lesions.

The completeness of the notification of cases was checked by two supervisors for each period of survey, from the list of admissions to the institutions.

Analysis

Patients of unknown age and sex were excluded from the analysis (1 per cent of total). In the event of transfer, only the first hospital admission for the episode was considered. Data concerning hospital admissions were extrapolated from the sample to provide annual estimates. To improve the accuracy of estimated injury rates, an attempt was made to adjust for the missing cases diagnosed outside the region. This adjustment was made on the basis of the 1984 mortality statistics.[23] Among deaths from injury having occurred in residents of Aquitaine, the proportions of cases registered outside the region were calculated by sex and age group, and the estimated injury rates were increased by the same proportions, on the assumption that admissions and deaths follow the same pattern. This proportion varied from 3.9 per cent to 10.7 per cent (6.3 per cent for the entire population).

Tables concerning the ISS were derived only from the admission sample, since this information was not available for death cases. ISS was analyzed both as a continuous variable and in classes, those being the categories widely used.[19,24]

*Details about the methodology are available from the author on request.

Results

All 21 public hospitals and 38 of the 43 private hospitals participated in the study. The participating institutions accounted for 97 per cent of the total traumatological activity in the region. The coefficient of extrapolation from the sample of admissions was 4.09.

Incidence

During the one-year period, 1,181 deaths were registered from the death certificates and 8,190 hospital admissions were observed during the sampling periods among residents of Aquitaine. After extrapolation of admissions on an annual basis and adjustment for the potential cases diagnosed outside the region, the overall incidence was 135.9 per 10,000 person years.

As expected, injury rates varied considerably by sex and age (Table 1). Men between 15 and 24 years of age and women over 75 years of age experienced the highest overall injury rates; except for ages 65 and over, male rates exceeded female rates, the difference being especially marked in the 15–34 year age group. However, mortality rates for males markedly exceeded those for females at all ages except those under age 10. In both sexes, mortality rates were highest over 75 years of age.

There was one immediate death for every 30 hospital admissions. The rate ratio of nonfatal to fatal cases was very high during childhood, then decreased until age 65 for females and age 75 for males. Except under age 10, the ratio was lower in males than in females.

External Cause of Injury

For all ages combined, falls on same level were the most common cause of fatal and nonfatal injuries (Table 2). When adding falls from high level, falls represented nearly 40 per cent of all reported cases of injury, yielding an incidence of 52 per 10,000 person years. Traffic accidents were the second commonest cause, followed by poisonings. These three leading causes accounted for 80 per cent of all admissions and deaths. When considering only fatal cases, the rank ordering of causes differed markedly. Traffic accidents ranked first, followed by accidents caused by firearms, hanging and strangulation, and drowning. The cause of injury was unspecified in 8 per cent of death certificates.

The nonfatal to fatal case rate ratio varied considerably with external cause of injury. For example, there was one immediate death in 150 admissions from falls on same level, against one in 20 from traffic accidents. In cases of drowning and hanging, the number of immediate deaths exceeded that of admissions. The ratio was also very low for injuries caused by firearms or electricity and very high for injuries produced by blunt objects and cutting or piercing instruments.

Origin of Injury

Among fatal and nonfatal cases of injury, 13.9 per cent were suicides or attempted suicides and 2.7 per cent were assaults or homicides (Table 3). Suicides and attempted suicides accounted for more than 80 per cent of cases of hanging/strangulation and poisonings, more than half of injuries due to firearms, and one-third of drownings. It should be noted that for this last cause, the origin was unknown in nearly 10 per cent of cases. More than 25 per cent of injuries from firearms were of accidental origin, hunting being a common sport in Aquitaine. Two suicides by electricity were reported.

TABLE 1—One-year Injury Rates per 10,000, by Sex and Age, Aquitaine, France, 1986

Age (years)	Sex	Hospital Admissions		Deaths		Overall Annual Rate*	Non-fatal/Fatal Rate Ratio
		No. in Sample	Extrapolated Annual Rate*	Annual No.	Annual Rate*		
<5	M	239	131.2	8	1.1	132.3	119.3
	F	165	91.3	7	1.0	92.3	91.3
5–9	M	225	120.2	5	0.7	120.9	171.7
	F	131	71.0	5	0.7	71.7	101.4
10–14	M	300	142.4	12	1.4	143.8	101.7
	F	159	77.3	2	0.2	77.5	386.5
15–24	M	1,244	268.4	122	6.5	274.9	41.3
	F	549	116.8	42	2.2	119.0	53.1
25–34	M	833	185.4	141	7.7	193.1	24.1
	F	386	82.7	33	1.8	84.5	45.9
35–44	M	578	147.1	104	6.5	153.6	22.6
	F	354	85.3	47	2.8	88.1	30.5
45–54	M	382	121.8	106	8.3	130.1	14.7
	F	258	75.3	39	2.8	78.1	26.9
55–64	M	389	109.5	130	9.0	118.5	12.2
	F	290	74.9	52	3.3	78.2	22.7
65–74	M	208	90.8	89	9.5	100.3	9.6
	F	286	103.3	40	3.5	106.8	29.5
≥75	M	298	172.4	104	14.7	187.1	11.7
	F	916	283.4	93	7.0	290.4	40.5
All ages	M	4,696	157.4	821	6.7	164.1	23.5
	F	3,494	106.7	360	2.7	109.4	39.5
	Both	8,190	131.3	1,181	4.6	135.9	28.4

*Rates were adjusted for the potential cases diagnosed outside the region.

Cause of Injury by Sex and Age

For both sexes, falls and traffic accidents ranked among the three leading causes at any age. Women over 75 years of age experienced the highest rate of falls on same level. Men were more exposed than women to falls from a high level, except during childhood where rates were similar in both sexes. Traffic accidents showed a marked peak in the 15–24 year age group, with a male/female ratio of incidence in this group of 2.5. Two distinct poisoning risk groups emerged: the first under 5 years of age, corresponding to accidental cases, and the second between 15 and 44 years of age, more marked in females and corresponding primarily to intentional poisonings. Injuries produced by blunt objects and cutting/piercing instruments showed an excess of male cases mainly concentrated during the working ages. Burns were more frequent in males at any age, and in both sexes, the highest risk was experienced under 5 years of age (Table 4).

Injury Severity Score (ISS)

Among patients having sustained traumatic injuries, the ISS ranged from 1 to 66 with a mean of 6.9. Eleven per cent of patients had an ISS higher than 10. Accidents caused by firearms yielded the highest values of both mean and proportion of ISS above 20. Traffic accidents and burns were also associated with a mean ISS value above average. Falls on same level often led to a score of 9, reflecting the fractures of limbs. In contrast, falls from high level were associated with higher proportions of scores in extreme classes, reflecting

TABLE 2—One-year Injury Rates per 100,000, by External Cause of Injury, Aquitaine, France, 1986

Cause of Injury	Hospital Admissions		Deaths		Overall Annual Rate*	Non-fatal/Fatal Rate Ratio
	No. in Sample	Extrapolated Annual Rate*	Annual No.	Annual Rate*		
Falls on same level	2366	379.4	63	2.5	381.9	151.8
Traffic accidents	2168	347.6	391	15.3	362.9	22.7
Poisonings	1202	192.7	69	2.7	195.4	71.4
Falls from high level	851	136.4	34	1.3	137.7	104.9
Struck by object	515	82.6	10	0.4	83.0	206.5
Cutting/piercing	509	81.6	6	0.2	81.8	408.0
Burns	121	19.4	11	0.4	19.8	48.5
Firearms	53	8.5	166	6.5	15.0	1.3
Insect/animal bite/sting	75	12.0	4	0.2	12.2	60.0
Drowning	25	4.0	137	5.4	9.4	0.7
Hanging/strangulation	12	1.9	159	6.2	8.1	0.3
Foreign body	41	6.6	5	0.2	6.8	33.0
Electricity	10	1.6	8	0.3	1.9	5.3
Miscellaneous	130	20.8	19	0.7	21.5	29.7
Unspecified	112	18.0	99	3.9	21.9	4.6

*Rates were adjusted for the potential cases diagnosed outside the region.

TABLE 3—Origin of Injury according to External Cause

External Cause of Injury	Annual Extrapolated Number*	Origin (%)			
		Suicide	Homicide Assault	Other	Unspecified
Traffic accidents	9260	0.1	—	99.2	0.3
Falls on same level	9740	—	1.3	98.5	0.2
Falls from high level	3510	2.4	0.2	97.0	0.4
Drowning	240	30.2	—	60.2	9.6
Foreign body	170	—	—	97.6	2.4
Struck by object	2120	0.6	25.0	73.4	1.0
Cutting/piercing	2090	5.9	5.2	87.8	1.2
Firearms	380	53.7	17.3	26.7	2.4
Burns	500	5.8	0.8	93.2	0.2
Poisonings	4990	80.7	0.2	18.0	1.0
Hanging/strangulation	210	89.7	8.3	1.0	1.0
Electricity	50	20.8	—	79.2	—
Insect/animal bite/sting	310	—	5.3	94.7	—
Miscellaneous	550	0.5	3.2	96.3	—
Unspecified	560	4.9	2.2	50.8	42.2
All causes	34,680	13.9	2.7	82.2	1.2

*Admissions × 4.09 + deaths.

accidents of different severity. Being struck by an object or cutting/piercing from instruments produced the least severe injuries (Table 5).

Outcome of Patients Admitted to Hospital

On the eighth day following injury, 31 per cent of patients admitted to hospital were still hospitalized and less than 1 per cent had died in hospital. When controlled for age by using the Standard Morbidity Ratio (SMR), burns, firearm accidents, and traffic accidents had proportions of patients still hospitalized above average. Hospital mortality was higher than average for traffic accidents, firearms and hanging, and lower for poisonings (Table 6).

The outcome within eight days correlated well with the ISS, mortality after admission and length of hospitalization both increasing with the score (Table 7).

Discussion

In contrast to studies based on medical records,[3,4,15] our data were specifically collected for this study, using an ad hoc questionnaire. This system of data collection was time-consuming for the medical staff of institutions in charge of completing questionnaires but, in return, data were more comprehensive and relevant than those derived from routine medical records.

This study does contain a number of possible biases. First, the field of study was limited to severe cases, i.e., cases either resulting in immediate death or requiring hospital admission. Hospital admission may be influenced by several factors independent of the actual severity of injury such as age, social conditions, access to medical service, hospital admission policy. Nevertheless, this criterion was no more subjective than the fact of attending at an accident and emergency department.

Concerning the sample of admissions, five of 43 private hospitals did not participate in the study. The extrapolation from the sample was adjusted for these missing data, taking surgical activity as criterion of reference although this did not exactly reflect the traumatological activity.

In participating institutions, completeness of notifications was checked by two supervisors using the list of admissions, but this list was not available in all private hospitals and some underreporting of cases in these institutions cannot be excluded. However, private institutions accounted for only 25 per cent of all admitted cases.

The number of deaths before admission may also be underestimated, since in case of a "suspect" cause of death, some certificates may have been sent directly to the legal authorities. These cases are later re-included in official mortality statistics, but they often have an unspecified cause of death, since legal authorities do not always send back the relevant information. In the 15–34 year age group, where it can be assumed that unspecified causes correspond mainly to violent deaths, we can predict from official mortality statistics that we may have missed about 9 per cent of cases. This

TABLE 4—One-year Injury Rates* per 10,000 by External Cause of Injury, Sex and Age, Aquitaine, France, 1986

Age (years)	Sex	Falls on Same Level	Traffic Accidents	Poisonings	Falls from High Level	Struck by Object	Cutting Piercing	Burns
0–4	M	28.9	13.8	28.5	29.5	4.6	8.3	8.3
	F	20.7	11.1	19.2	25.8	3.9	2.8	3.3
5–9	M	41.3	25.8	3.8	23.1	10.2	5.4	1.6
	F	22.0	10.5	2.7	24.7	7.0	2.7	1.2
10–14	M	51.0	42.8	2.9	17.6	13.4	6.8	1.4
	F	26.2	21.6	7.8	16.5	2.4	2.4	0.5
15–24	M	35.4	127.8	25.3	16.7	28.8	22.6	4.1
	F	10.4	49.6	43.2	5.4	1.7	5.0	1.3
25–34	M	25.5	58.8	25.0	20.8	20.0	21.8	2.9
	F	5.9	23.1	43.4	3.5	1.5	4.6	1.5
35–44	M	23.5	37.8	20.4	19.4	17.4	15.3	2.8
	F	9.8	23.8	37.9	4.5	2.0	3.2	1.5
45–54	M	17.8	34.1	9.8	24.5	13.1	14.4	2.2
	F	14.4	24.5	23.4	5.6	2.6	2.9	1.6
55–64	M	23.2	33.2	6.2	15.6	10.5	13.5	0.9
	F	36.1	15.5	11.0	4.2	1.5	1.0	0.5
64–74	M	32.9	31.5	2.9	13.4	3.6	4.9	1.7
	F	62.8	14.0	6.1	9.0	3.2	1.4	0.7
≥75	M	106.3	31.8	10.1	16.5	4.2	4.0	1.7
	F	235.6	15.5	6.2	9.8	2.2	2.5	1.4
All ages	M	33.7	50.7	15.1	19.1	14.7	13.8	2.7
	F	42.2	23.0	23.6	8.9	2.4	3.0	1.3

*Rates were adjusted for the potential cases diagnosed outside the region.

TABLE 5—Classes of Injury Severity Score (ISS), Mean and Range according to External Cause of Injury

External Cause of Injury	Classes of ISS (%) 1–4	5–9	10–19	≥20	Mean (S.D.)	Minimum Maximum
Traffic accidents	34.1	43.7	15.7	6.5	8.2 (0.16)	1–66
Falls on same level	38.5	57.4	3.5	0.6	6.7 (0.07)	1–36
Falls from high level	44.8	42.6	10.6	2.0	7.0 (0.16)	1–34
Struck by object	62.5	32.0	4.3	1.2	5.0 (0.20)	1–41
Cutting/piercing	73.6	22.8	3.0	0.6	4.8 (0.14)	1–25
Firearms	49.1	24.5	3.8	22.6	10.2 (1.66)	1–50
Burns	51.2	33.8	10.0	5.0	8.0 (0.62)	4–29
All traumatic causes	43.7	44.9	8.4	3.0	6.9 (0.07)	1–66

underestimation presumably affected suicides and homicides.

With respect to the estimates of injury rates, we had to assume that fatal and nonfatal cases followed the same pattern for potential cases diagnosed outside the region, an assumption which may not be accurate.

Lastly, hospital mortality possibly is underestimated, since in cases of a secondary transfer to another institution, the occurrence of death in the secondary institution was not known. However, this underestimation is doubtless slight (only 4 per cent of cases were secondarily transferred). Hospital mortality assessment was limited to eight days, because it did not seem feasible to maintain a longer follow-up in all institutions. This limitation does not affect equally all types of injury, delayed deaths being more frequent for some causes and ages.

The comparison of our results with those of other studies is difficult since many differences exist in definition and case ascertainment, time and place of study, and analysis. Nevertheless, many findings are similar to those reported by previous studies,[3,4,12–16] concerning the main causes of injury and the patterns of incidence by age and sex.

The major contributions of this study lie in two areas. First is the assessment of the ratio of nonfatal to fatal cases.

TABLE 6—Outcome at the Eighth Day following Injury of Patients Admitted to Hospital, according to External Cause of Injury

External Cause of Injury	Number of Cases	Still Hospitalized %	SMR	Died in Hospital %	(Nb)	SMR
Traffic accidents	2168	31.3	1.16*	1.4	(31)	1.94*
Falls on same level	2366	44.4	1.01	0.8	(20)	0.71
Falls from high level	851	30.8	1.02	0.8	(7)	1.02
Drowning	25	24.0	0.91	—		—
Foreign body	41	10.3	0.40°	—		—
Struck by object	515	16.9	0.62*	0.2	(1)	0.27
Cutting/piercing	509	14.3	0.52*	—		—
Firearms	53	49.1	1.73*	7.5	(4)	9.22+
Burns	121	61.0	2.28*	0.8	(1)	1.23
Poisonings	1202	17.4	0.70*	0.1	(1)	0.16°
Hanging/strangulation	12	41.7	1.57	8.3	(1)	11.56+
Electricity	10	20.0	0.72	—		—
Insect/animal bite/sting	75	11.1	0.38*	1.3	(1)	1.88
Miscellaneous	130	27.9	0.96	—		—
All causes	8190	31.3	1.0	0.8	(67)	1.0

SMR = Standardized morbidity (mortality) ratio. SMR = [Observed number of cases still hospitalized (died) for a given cause/Expected number when applying the overall rate of patients still hospitalized (died)]. *$p < 0.001$; °$p < 0.05$; +expected number smaller than 5.

TABLE 7—Outcome at the Eighth Day following Injury of Patients Admitted to Hospital, according to Classes of ISS

Classes of ISS	% Still Hospitalized	% Died in Hospital
1–4	17.7	0.1
5–9	42.2	0.5
10–19	58.5	1.1
≥20	69.9	18.5

The ratio is very high during childhood, because hospital admissions are frequent and mortality very low. From 15 to 75 years of age, the ratio regularly decreases since rate of fatal cases increases, while that of nonfatal cases decreases. In the elderly, the ratio rises again, especially in women, despite a continuing increase of immediate mortality. This is explained by the high admission rates at this age and by the fact that deaths are more often delayed, as mentioned above. The low ratios of nonfatal to fatal cases for certain external causes, such as accident by firearms, drowning, and hanging/strangulation, emphasize the fact that studying severe cases only from hospital-treated cases does not provide an accurate view of the magnitude of the problem.

The second contribution of this study is an in-depth description of the severity of injuries using the ISS. We have not found such an evaluation of the ISS within an entire injured population in the literature. The ISS was initially developed for traumas resulting from traffic accidents, but according to its authors, its use for rating other accidents is possible on condition that similar injuries are involved.[18] Moreover, the 1980-AIS version incorporated many more injuries to internal organs, making the AIS more suitable for rating severity of non-vehicular penetrating injuries.[21] Its application may be questionable for rare causes, such as firearm accidents.[25]

We developed a methodology for automatically computing the ISS, as proposed by other authors.[26] The purpose was to eliminate the inter- and intra-rater variability among coders, a problem which has been often pointed out.[21,25–27] This problem was important in our study, which involved many institutions. Automatic computation was also time-saving and less costly, two necessary conditions to make the study feasible, even at the expense of some loss of precision. MacKenzie,** reporting the results of an experiment of conversion of the International Classification of Diseases to AIS, had already stimulated interest in such a tool, even not perfect.

The ISS could be assessed only on patients admitted to hospital, since in cases of death a postmortem examination would have been necessary to identify all lesions. This minimizes the proportion of upper scores for causes having a high immediate mortality, such as traffic accidents or firearms injuries. Despite this bias, these causes were nevertheless associated with the highest severity scores among hospital-treated patients.

This study confirmed that the ISS correlated well with mortality and length of hospitalization, as previous studies have reported.[18,19] However, it is not a good predictor of

**McKenzie EJ, Steinwachs DM, Shankar B: Classifying trauma severity based on hospital discharge diagnoses: validation of an ICD-9CM to AIS-85 conversion table (not published).

post-trauma disability.[24] Further exploration of this last aspect is needed as the improvements in survival from injuries may lead to an increase in later disability.

ACKNOWLEDGMENTS

This study was supported by the Direction Régionale des Affaires Sanitaires et Sociales d'Aquitaine, the Conseil Régional d'Aquitaine, the Caisse Régionale d'Assurance Maladie d'Aquitaine, the Ministère de l'Equipement, du Logement de l'Aménagement du Territoire et des Transports (Sécurité Routière), and the Ministère de l'Intérieur (Sécurité Civile). The authors gratefully acknowledge the cooperation given by the institutions which participated in the study. We also wish to thank E. Michel and V. Lambert for computer programming, C. Cretaz for collecting deaths certificates, and B. Mrabet and D. Rebeyrol for supervising the data collection in institutions.

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