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COMPARISON OF MORTALITY DUE TO SEVERE MULTIPLE TRAUMA IN TWO COMPREHENSIVE MODELS OF EMERGENCY CARE: ATLANTIC PYRENEES (FRANCE) AND NAVARRA (SPAIN)

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□ **Abstract—Background: Injury due to external causes is an important health problem in our society today. Emergency care systems based on the concept of "comprehensive care" can prevent deaths and disabilities as well as limit the severity and pain caused by trauma. Objective: To investigate the frequency and characteristics of different mechanisms of injury and to estimate mortality, comparing two comprehensive emergency systems: Atlantic Pyrenees (AP) in France and Navarra (NA) in Spain. Material and Methods: A prospective cohort study of severe multiple-injury patients attended to by the comprehensive emergency care systems of AP and NA from April 1, 2001 to March 31, 2002. Data were collected from personal patient data, the emergency coordination center "112," pre-hospital and hospital health care levels, and discharge data. Bivariate statistical analysis and multivariate logistic regression models were employed for statistical management. Results: There were 614 severe multiple trauma patients recorded, 278 in AP and 336 in NA. Significant differences were observed in arrival time, pre-hospitalization care, pre-hospital Revised Trauma Score (RTS), Injury Severity Score (ISS) at the intensive care unit, and procedures used (intubation, administration of fluids, immobilization, and diagnostic methods). Logistic regression showed significant differences in patient death, age (odds ratio [OR] 1.02, 95% confidence interval [CI] 1.01–1.03), penetrating or accidental injuries, (OR 3.85, 95% CI 1.1–13.1), RTS (OR 0.58, 95% CI 0.5–0.7), and ISS score (OR 1.05, 95% CI 1.0–1.1). Conclusion: Despite a more aggressive approach and employment of greater resources, the French comprehensive trauma system does not show greater survival rates among injured patients compared to Navarra, even when controlling for confounding factors like age, injury mechanism, RTS, ISS, and others.** © 2009 Elsevier Inc.

□ **Keywords—severe multiple trauma; comprehensive emergency care systems; mortality; trauma systems**

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INTRODUCTION

Injuries due to external causes are a serious public health problem, not only for the high morbidity and mortality rates or the financial, social, and psychological sequelae

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for victims, but also for the burden on health care systems that such events incur (1,2).

Injuries due to external causes include all non-intentional ones (traffic crashes, falls, accidental poisoning, burns, near-drowning, sports- and leisure-related injuries) and intentional injuries (homicides, suicides, war, domestic violence involving adults or children). They are classified according to the International Classification of Diseases, 10th Revision (U01–U03, V01–Y36, Y85–Y87, Y–89).

According to the World Health Organization, in 2003 more than 5 million deaths occurred due to external causes, 68% of which were non-intentional (3). More than 50% of deaths affect young adults between 15 and 44 years of age (4). In addition, they cause disabilities to more than 50 million people annually, a rate that can continue increasing if the necessary measures are not taken.

In our context, injuries by external causes represent the fourth cause of global mortality in the population in all ages and are the first cause of mortality in people under 45 years of age. Eight percent of all disabilities in the population are due to injuries (5). In 2000, there were 16,451 and 41,436 deaths due to external causes in Spain and France, respectively (6).

The management of multiple-injury victims has developed rapidly in recent decades, with important improvements like the introduction of trauma systems based on the concept of "comprehensive care" (7). However, many countries face the risk of higher mortality due to delays in the detection of trauma events, the application of basic life support at the scene of the crash (both low-cost measures), and delays in transfer times to an adequate hospital with sufficient resources (high-cost measures) and posterior rehabilitation. The initial objectives of assistance (first 2 h) after the event takes place are aimed at preventing death and avoidable sequelae, limiting severity of the injuries and suffering incurred, and safeguarding an optimal evolution of the survivors, and their reinsertion in society. This is carried out by a chain of health assistance, the first agent of which is the citizen who witnesses the event (8,9).

International experience shows that such systems can avoid 10–30% of mortality rates, prevent a large amount of sequelae, and reduce the economic burden caused by injuries (reduction in mortality and severity of injuries, the transcendence of sequelae, reduction in hospital stay, and favor social and work reinsertion) (10–14). These systems also limit health expenses by regionalizing and avoiding duplication and under-use of health services, increase citizen's confidence in the health care system, and reduce response times (health personnel, health centers, ambulances, and helicopters) (15–17).

In Navarra, after a few years of implementation and consolidation of a comprehensive emergency system, an evaluation process was carried out to correct deviations and make comparisons with other similar systems. In this context, our study, which is based on the premise that management and survival of the severe-multiple-injury victim (SMIV) are good indicators of quality in the performance of emergency systems, compares the emergency system in Navarra (NA) and the French emergency system employed in the region of the Atlantic Pyrenees (AP) (18,19). The French model is regarded as a solid and prestigious comprehensive emergency system with which our region shares common characteristics due to its geographical proximity.

During the period of study, the AP region had a population of 592,000 inhabitants (355,000 of them in Pau and 237,000 in Bayonne) and NA had 555,829 inhabitants.

As for standard of living, customs, and infrastructure, there are no great differences taking into account the nearly always greater level of development on the French side. Also similar was the profile of the populations; in the Pyrenees, the major settlements are around the BAB zone (Biarritz - Anglet - Bayonne) and Pau, and in Navarra, 70–75% of the population and industry lies in Pamplona, Estella, and Tudela. The rest corresponds to rural areas with agricultural activity and an aged and dispersed population (Table 1).

With the exception of a few particularities, health resources, hospital infrastructure, and organization of emergency services are very similar in both systems. The management of severe trauma victims is very much

Table 1. Comparison of Pre-hospital Health Resources: Rate of 1 Resource or Medical Team per 100,000 Inhabitants

	SMUR	Vehicles	Helicopter	Medical Teams	SMUR (Rate)	Vehicle (Rate)	Helicopter (Rate)	Teams (Rate)
Atlantic Pyrenees								
Total	4	12	3	7	0.67	2.02	0.50	1.18
Pau	3	6	1	4	0.84	1.70	0.28	1.12
Bayonne	1	6	2	3	0.42	2.53	0.84	1.26
Navarra	3	4	1	4	0.54	0.72	0.18	0.72

SMUR = Medical Emergency and Resuscitation Services.

alike, with similar limitations, such as the absence of infant heart surgery or a severe burns unit.

Regarding pre-hospital care, it is two-tiered in both regions, with medicalized and non-medicalized resources. Non-medicalized resources (basic life support ambulances) consist of certified auxiliary ambulance technicians. Paramedic personnel, as they are known in the United States and other Anglo-Saxon countries, do not exist in the pre-hospital management teams in either PA or NA. Medicalized resources (ambulances and helicopters with advanced life support) responsible for medical assistance include physicians, registered nurses, and auxiliary ambulance technicians.

Both Navarra and the Atlantic Pyrenees have a single emergency call number (Emergency Medical Care Service (EMS) 112) from which the caller is put into contact with the coordination and dispatch center.

The objective of our study was to investigate the frequency and characteristics of mortality by different mechanism of injury and to estimate mortality, comparing each comprehensive emergency system. In addition, we wanted to analyze whether variables influenced the final outcome (patient's death or survival).

MATERIALS AND METHODS

We studied and compared a prospective cohort of severe-multiple-injury patients attended to in each of the comprehensive emergency systems in Navarra and the Atlantic Pyrenees (EMS 64 A and 64 B) between April 1, 2001 and March 31, 2002.

Patients studied included those serious-multiple-injury victims who received medical assistance or complied with the following criteria:

1) Revised Trauma Score (RTS) < 12 at any point of the care process (20).
2) Severe life-threatening injuries or injuries that could provoke serious sequelae: epidural or subdural hematoma, tension pneumothorax, massive hemothorax, massive cardiac tamponade, grand vessel rupture, hemoperitoneum causing shock, blunt visceral rupture, fracture/dislocation C1–C7.
3) Admission to an intensive care unit (ICU) in any hospital.
4) Surgical intervention in thorax or abdomen in the first 24 h: liver or spleen rupture, hemothorax, or pelvis stabilization.
5) Death at any point during medical assistance.

Patients were followed-up from the first contact with emergency services up to death or discharge from the hospital.

Data were collected from all available sources. In each region a person was in charge of gathering information twice a week (Mondays and Fridays). This information was recorded in a database. Data were obtained from different systems: emergency coordination centers and registers from the medical ambulances, helicopters, hospitals, Emergency Departments (EDs), and ICUs. Other sources of data included forensic reports and death certificates, public registers, automatic registers of complementary tests (ultrasound, computed tomography [CT]), and anesthesia and surgical notes. A specific data sheet was designed for each level of assistance.

All centers and professionals involved were previously informed of the study and were committed to the recording of a series of data relevant to the study.

For data collection purposes, Microsoft® ACCESS 97 (Microsoft Corporation, Redmond, WA) was used in both regions, facilitating posterior statistical analysis and comparison.

Variables at different levels recorded included:

1) Patient personal and demographic data: identity, age (years), sex.
2) Coordination center (EMS 112): date, site, and characteristics of the event, mechanism of injury (penetrating, traffic, fall), type of event (non-intentional work-related, aggression, autolysis), emergency resource dispatched (medical ambulance, helicopter), time of arrival, interval of assistance from arrival at scene to arrival at hospital, and total time interval between occupancy and availability for new medical attention.
3) Pre-hospital care: advanced life support, immobilization, RTS.
4) ED: life support measures, immobilization, RTS, diagnostic and complementary tests.
5) Intensive care: Injury Severity Score (ISS), previous morbidity, mean ICU length of stay (days) (21).
6) Hospital discharge: mean hospital length of stay (days), survival, death, evaluation of neurological function-Glasgow-Pittsburgh scale (GOS) (22).

Statistical management was carried out with SPSS® 12.0 (SPSS Inc., Chicago, IL). Quantitative variables were described with mean and standard deviation in case of normal distribution, and median, minimum, and maximum values in cases of abnormal distribution.

The chi-squared test was used to evaluate the association between qualitative variables. In normal distributions, comparison of means of independent samples was conducted with Student's *t*-test and analysis of variance (after confirmation of homogeneity of variances by Levine test). Non-parametric equivalents were evaluated with Mann-Whitney and Kruskall-Wallis tests. Correla-

tion between quantitative variables was carried out with Pearson's correlation coefficient (r) or Spearman's r according to whether or not variables followed a normal distribution.

To conclude, multivariate logistic regression was used to estimate the independent effect of different variables on mortality. The dependent variable was death or not, and the independent variables included those that showed statistical significance in bivariate analysis and those considered relevant for adjustment purposes. Results were presented as odd ratio (OR) with 95% confidence interval (CI). Model adjustment was measured with the chi-squared test for goodness-of-fit. The accepted level of statistical significance was $p < 0.05$.

RESULTS

During the study period, 614 cases of severe multiple trauma were recorded, 278 of them (45.3%) in AP and 336 (54.7%) in NA. The descriptive characteristics and comparative results after bivariate analysis of the 614 patients from both regions are shown in Table 2.

There were no significant differences between AP and NA for the following variables: mean age, sex, days of the week on which the event occurred, crude mortality, mortality in situ (62.3% in AP and 70.3% in NA), number of days before death (Figure 1), mean hospital length of stay, mean length of stay in the ICU, and types of injury sustained in which the differences were nearly significant ($p = 0.06$).

Significant differences ($p < 0.05$) were identified for mechanism of injury (Figure 2), resource employed by first pre-hospital responders (90.4% medical ambulance), delay in arrival (20.5 min, SD 11.7), time of pre-hospital assistance (50.2 min, SD 24.1), occupation time of the pre-hospital resource (64.5 min, SD 31.8), and site where death was deferred (Figures 3, 4). For these variables, values in AP were higher than in NA.

There were differences in the pathophysiological state of the 404 victims found alive on first contact with a health provider, and in the application of medical procedures, as shown in Table 3.

As for pre-hospital care (Figure 5), significant differences ($p < 0.05$) were found, and again values were higher in AP than in NA, for early notification of the ED before arrival (95.8%), apnea (43.7%), no palpable pulse (6.9%), application of CPR on arrival (14.3%), cervical immobilization (76%), administration of supplemental oxygen (91.6%), intubation (34.9%), mechanical ventilation (32.4%) establishment of vascular access (92.5%), and mean pre-hospital RTS (9.7 in AP whereas in NA the mean RTS was 10.7). Total fluid replacement was much higher in NA than in AP.

Regarding the ED (Figure 6), differences reached statistical significance ($p < 0.05$) in the number of cardiopulmonary resuscitations (CPRs), with 12% (20 SMIV) in AP, and 2.4% (5 SMIV) in NA; chest X-ray studies (96.5%); and cranial CT scans (70.1%). Values for these variables were higher in AP than in NA. However, for diagnostic peritoneal lavage and abdominal sonography-CT scan (50.3%) and total fluid therapy, values were higher in NA than in AP.

In the ICU, significant differences ($p < 0.05$) were observed, with higher values in the ISS calculated on admission to ICU (23.5, SD 11.6) in NA than in AP (18.8, SD 16.4).

Regression Models

To determine whether the difference in survival was influenced by the region where the event occurred (main independent variable), or whether it could be attributed to the different independent confusion factors, we used multivariate logistic regression.

Multivariate regression models 1 to 3 included all major trauma victims (Table 4), whether alive or dead, on first contact with health providers of the comprehensive trauma system. It was worth noting that on increasing the number of variables in the model, the lesser the number of cases that could be analyzed due to loss of information in some variables.

In model 1 (n = 611), the dependent variable was death. Independent variables included region (NA or AP), age (range 2–96 years), and sex (man or woman).

In this model, we found that given the same age and sex, the fact that the event occurred in the AP region meant an increase in the probability of dying up to 22%, although this difference was not significant. It was also observed that for each additional year of age, the risk of dying increased by 2%, with statistical significance (OR 1.02, 95% CI 1.01–1.03). Being male was protective, with a probability of dying of < 16%, although this was not significant. This was the most simple multivariate logistic regression model elaborated, which controlled for age and sex and from which we cannot conclude that mortality in the regions differed, and which explains only 5% of the variability observed in mortality in severe SMIV.

In model 2 (n = 251), we added independent variables like type of injury. As a reference we used mechanism of accidental injury vs. penetrating mechanisms or slip-and-fall or intentional fall and pre-hospital RTS. Given the same age and sex, and mechanism of injury (accidental, penetrating, or fall), the probability of dying increased if the crash occurred in AP by 58%, although this difference was not significant.

It was also observed that mortality by penetrating injury is nearly four times higher than by an accidental

Table 2. Characteristics of the Sample Studied by Region and Level of Significance of the 614 Cases of Severe Trauma

	Atlantic Pyrenees $n = 278$				Navarra $n = 336$				
	n/Missing	Mean (DE)	Median and Range (Minimum–Maximum)	% Total	n/Missing	Mean (DE)	Median and Range (Minimum–Maximum)	% Total	Significance p
Quantitative variables									
Age (year)	275/3	45.61 (23.07)	42 (2–92)		336/0	45.27 (21.45)	42 (2–96)		0.850
Delay in first contact	242/36	20.48 (11.72)	18 (0–71)		101/235	15.99 (13.46)	14 (0–92)		0.002
Pre-hospital assistance time	157/121	50.17 (24.08)	45 (0–160)		43/293	40.26 (25.50)	32 (8–136)		0.019
Occupation time	167/111	64.48 (31.80)	60 (0–194)		101/235	46.41 (34.21)	14 (0–92)		<0.001
Qualitative variables									
Region	278/0			45.3%	336/0			54.7%	
Sex	278/0				336/0				0.227
Men	200			71.9%	257			76.5%	
Women	78			28.1%	79			23.5%	
Day of the week	278/0				336/0				0.193
Sunday	47			16.9%	54			16.1%	
Monday	41			14.7%	52			15.5%	
Tuesday	42			15.1%	30			8.9%	
Wednesday	35			12.6%	38			11.3%	
Thursday	34			12.2%	58			17.3%	
Friday	36			12.9%	42			12.5%	
Saturday	43			15.5%	62			18.5%	
Type of injury	278/0				336/0				0.062
Accidental	214			77.0%	261			77.7%	
Work related	15			5.4%	34			10.1%	
Agression	10			3.6%	9			2.7%	
Autolysis	39			14.0%	32			9.5%	
Death	278/0				336/0				0.224
Yes	151			54.3%	165			49.1%	
No	127			45.7%	171			50.9%	
Death	278/0				336/0				0.138
In situ	94			33.8%	116			34.5%	
Deferred	57			20.5%	49			14.6%	
No death	127			45.7%	171			50.9%	
Site of deferred death	57/0				49/0				0.040
Transfer	6			10.5%	4			8.2%	
Emergency dept	18			31.6%	6			12.2%	
Surgery	4			7.0%	1			2.0%	
ICU	25			43.9%	27			55.1%	
Hospitalization	4			7.0%	9			18.4%	
Hospitalization at ICU	0			0.0%	2			4.1%	
First field assistance	219/59				212/124				<0.001
Private vehicle	4			1.2%	1			0.5%	
Conventional ambulance	2			0.9%	53			25.0%	
Medicalized ambulance	135			61.6%	156			74.6%	
Helicopter	63			28.8%	2			0.9%	
Other	15			6.8%	0			0.0%	

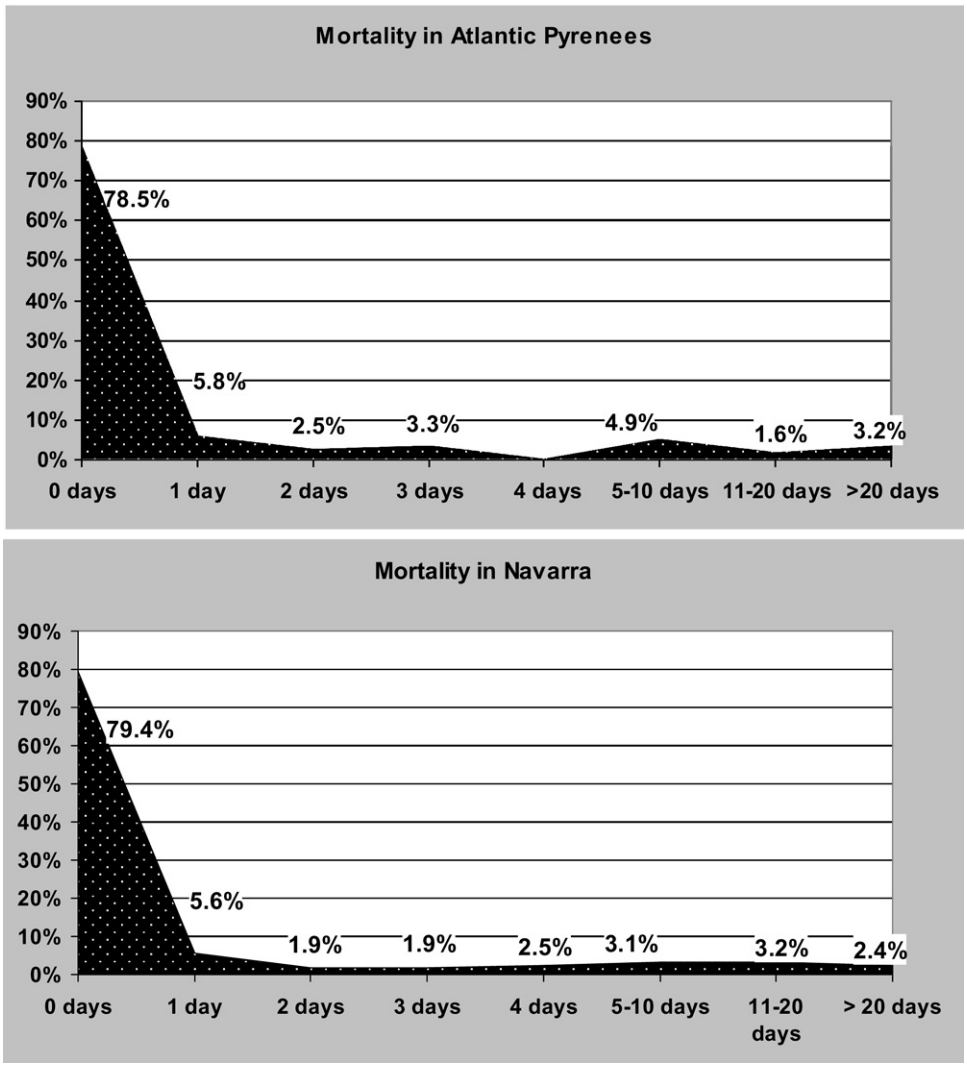

Figure 1. Periods of mortality in a severe multiple injury victim.

mechanism; this difference was significant (OR 3.85, 95% CI 1.1–13.1). As for falls, mortality increased slightly, by 5%, if it was accidental, although the difference was not significant. For each point reduced in the RTS score, mortality rose by 42%, with significant effects (OR 0.58, 95% CI 0.5–0.7). With this model we could explain 47% of the variability observed in mortality in major trauma victims.

In model 3 (n = 121), we added the independent variable ISS at ICU. Given the same age, sex, mechanism of injury, pre-hospital RTS and ISS at ICU, then the probability of dying if the accident occurred at AP was more than 79% higher than if it occurred in NA, although this difference was not significant. For every additional point in the ISS, mortality was raised by 5%, and this was a significant effect (OR 1.05, 95% CI 1.0–1.1). This model accounts for nearly 39% of the variability observed in mortality.

To complete our investigation with multivariate logistic regression, we studied those patients who were alive at first contact with first responders of the comprehensive trauma system (n = 404) in models 4–6, taking into account only the procedures carried out, regardless of the region where the event took place (Table 5).

In model 4 the dependent variable was death. Independent variables included: age, sex, injury mechanism (mechanism of reference, accidental vs. penetrating, fall) and pre-hospital RTS. In this model (n = 216), for each additional year of age, the probability of dying was 5% higher, the difference being significant (OR 1.05, 95% CI 1.03–1.07). There was a higher risk of dying in women (14% higher probability than in men), although the differences were not significant.

The risk of mortality in penetrating injuries was five times higher than in accidental ones, with significant dif-

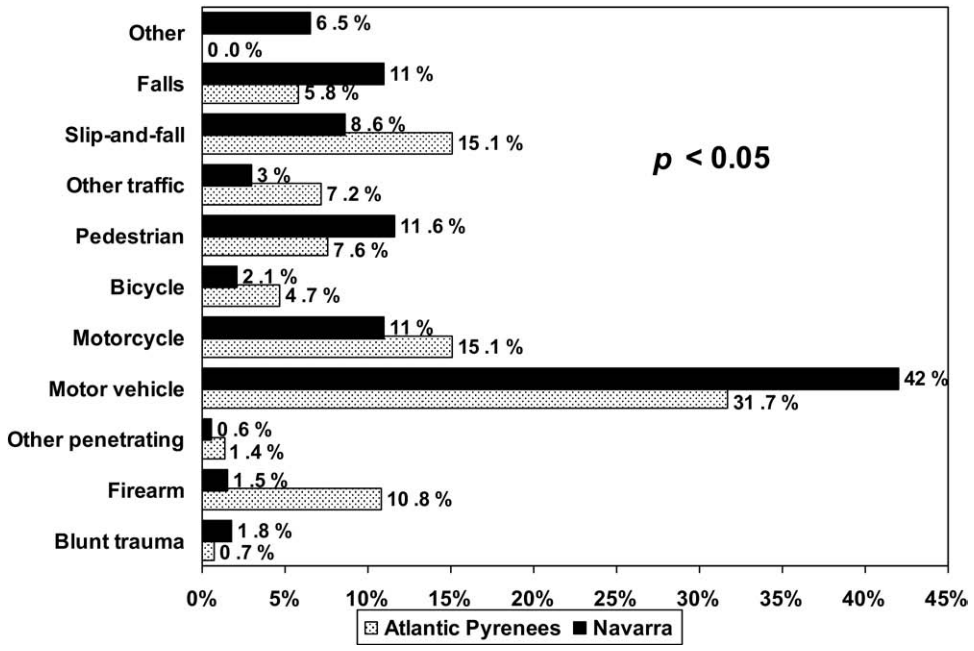

Figure 2. Mechanism of injury.

ferences (OR 4.82, 95% CI 1.5–15.6). In the case of falls, mortality was also higher (21%) than in accidental events, although the difference was not significant. Moreover, for every reduced point in the pre-hospital RTS, mortality increased by 37%, with significant differences (OR 0.63, 95% CI 0.5–0.7). This model explains variability observed in mortality in 34% of the cases.

In the fifth model (n = 114), we added the ISS at ICU. Given the same age, sex, injury mechanism, and pre-hospital RTS, for every increased point in ISS, mortality increased by 7%, with significant differences (OR 1.07, 95% CI 1.01–1.13). This model explains up to 31% of variability observed in mortality of SMIV who were alive at first contact with pre-hospital health providers.

In model 6 (n = 105), the independent variables added were intubation and total fluid volume. For the same age, sex, injury mechanism, pre-hospital RTS and ISS at ICU, the risk of dying in intubated patients was > 31% higher than if not intubated, although the difference was not significant. Fluid replacement did not modify mortality. This model could account for up to 29% of deaths in major trauma victims.

DISCUSSION

In accordance with other studies, ours did not find differences regarding sex. The incidence of crashes in men was three times higher than in women (23).

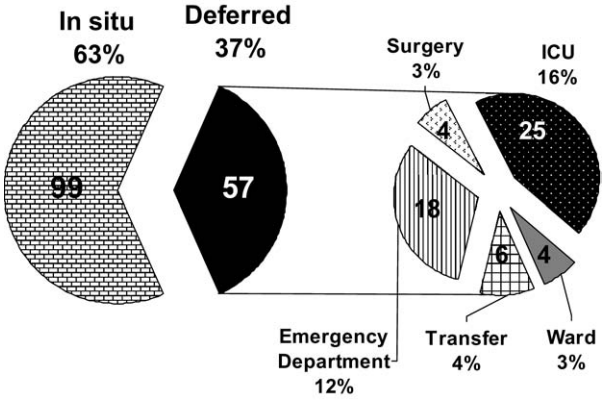

Figure 3. Mortality in the Atlantic Pyrenees: 156 of 278 (51%).

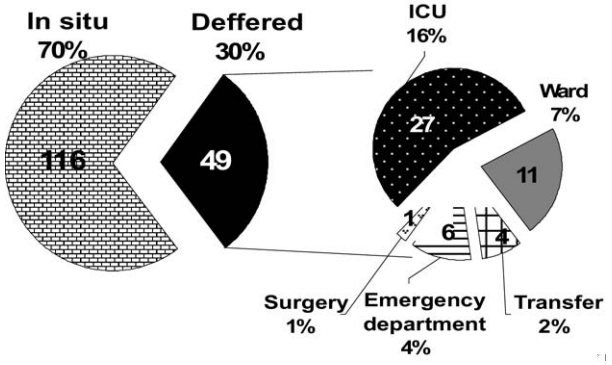

Figure 4. Mortality in Navarra: 165 of 336 cases (49%).

Table 3. Characteristics of the Sample by Region and Significance Level of the 404 Patients Found Alive at First Contact with Pre-hospital Health Providers

	Atlantic Pyrenees $n = 184$				Navarra $n = 220$				
Variable	n/Missing	Mean (DE)	Median and Range (Minimum–Maximum)	% Total	n/Missing	Mean (DE)	Median and Range (Minimum–Maximum)	% Total	Significance p
Quantitative variables									
Age (year)	184/0	46.53 (24.09)	43 (2–92)		220/0	45.66 (23.12)	40 (2–96)		0.712
Pre-hospital RTS	145/39	9.71 (3.02)			75/145	10.75 (2.04)			0.008
Total pre-hospital volume	154/30	755.84 (573.3)	500 (100–3500)		139/81	978.78 (825.6)	500 (0–4000)		0.007
RTS at ED	176/8	10.21 (2.24)			210/10	10.12 (2.84)			0.744
Total fluid ED	167/17	951.50 (891.7)	600 (100–5000)		165/55	1653.64 (1220.4)	1500 (0–6500)		<0.001
ISS at ICU	54/124	18.76 (16.37)	16 (1–75)		189/31	23.46 (11.60)	25 (4–75)		0.019
Length of stay ICU	115/63	11.25 (17.11)	4 (0–123)		188/32	9.61 (13.70)	4 (0–92)		0.358
Days up to death	45/139	9.13 (23.57)	1 (0–123)		47/173	5.4 (9.14)	1 (0–38)		0.313
Days admitted	154/30	25.62 (30.23)	16 (0–174)		215/5	20.94 (24.28)	13 (0–161)		0.123
Qualitative variables									
Sex	184/0				220/0				0.585
Men	131			71.2%	162			73.6%	
Women	53			28.8%	58			26.4%	
ED notification	165/19				203/17				<0.001
Yes	158			95.8%	120			59.1%	
No	7			4.2%	83			40.9%	
Cranial CT scan at ED	167/17				210/10				0.038
Yes	117			70.1%	124			59.0%	
No	50			29.9%	86			41.0%	
Thoracic CT scan at ED	153/31				210/10				0.281
Yes	68			44.4%	81			38.6%	
No	85			55.6%	129			61.4%	
DPL-ECO-abdominal TAC at ED	149/35				209/11				0.009
Yes	75			50.3%	135			64.6%	
No	74			49.7%	74			35.4%	

RTS = Revised Trauma Score; ED = Emergency Department; ISS = Injury Severity Score; ICU = Intensive Care Unit; CT = computed tomography; DPL = diagnostic peritoneal lavage; ECO = ecography; TAC = Tomografía axial computarizada (Computerized axial tomography CAT).

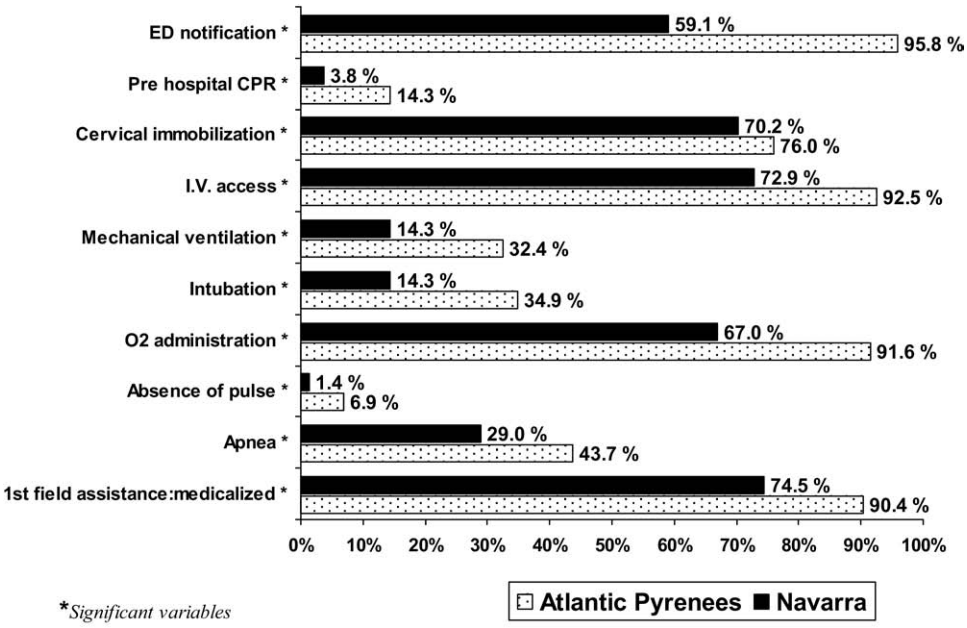

Figure 5. Pre-hospital differences.

There were no differences in the day of the week on which the event occurred, with maximum values on Saturdays and Sundays, 17.1% and 16.4%, respectively, a finding also identified in an Italian report (23).

With regard to mechanism of injury, again no significant differences were observed in traffic crashes on both sides of the Pyrenees, although there was a higher incidence of both motorcycle and bicycle crashes in AP, whereas in NA, motor vehicle crashes and pedestrian injuries were higher. There were, however, significant differences in penetrating injuries, accounting for 12.9% in AP (blunt trauma or firearm), and only 3.9% in NA. Possibly, these differences can be attributed to cultural factors and lifestyle. This idea is also present in studies from other countries. Thus, in the United States and Uruguay, firearms account for more than 11% and 38%

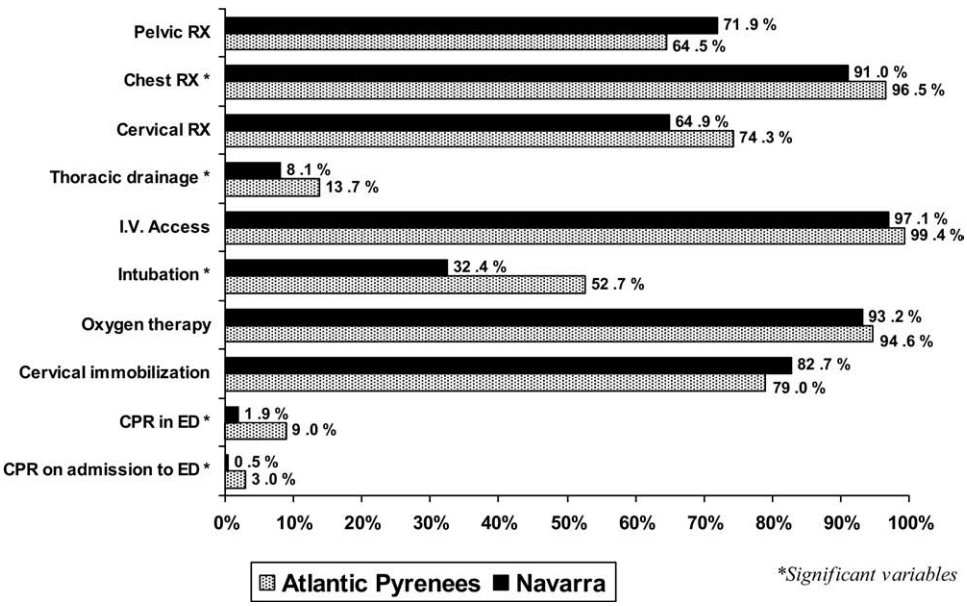

Figure 6. Differences at the Emergency Department.

Table 4. Logistic Regression: Three Models by Region-Age-Sex-Mechanism-RTS-ISS-Time to First Contact and Time of Pre-hospital Assistance (Maximum n = 614 cases)

Models	Model 1			Model 2			Model 3		
Variable	OR	95% CI Inferior	95% CI Superior	OR	95% CI Inferior	95% CI Superior	OR	95% CI Inferior	95% CI Superior
Region contact	1.22	0.88	1.69	1.58	0.64	3.90	1.79	0.45	7.10
Age (years)	1.02	1.01	1.03	1.05	1.03	1.07	1.06	1.03	1.10
Sex	0.84	0.57	1.23	2.01	0.85	4.74	2.37	0.62	9.13
Injury mechanism: penetrating				3.85	1.14	13.07	7.40	1.20	45.77
Injury mechanism: fall				1.05	0.35	3.10	3.40	0.66	17.44
Prehospital RTS				0.58	0.50	0.68	0.66	0.52	0.84
ISS on ICU admission							1.05	1.0	1.11
n	611			251			121		
Cox R and Snell	0.05			0.47			0.39		
−2 log of verisimilitude	812.6			169.3			73.9		

OR = odds ratio; CI = confidence interval; RTS = Revised Trauma Score; ISS = Injury Severity Score; ICU = Intensive Care Unit.

of injuries, respectively, whereas in Australia and Italy, the incidences are much lower (2,23–25).

It is interesting to note that significant differences were found regarding health resources directed at attending major trauma. In the French region, the resource was medicalized in 90% of the cases, whereas in Navarra, it was medicalized in 75% of the cases; that is, 1 in every 4 SMIV was initially attended to by paramedic personnel in NA. In comparing this study with others, rates of medicalized management of major trauma were similar to or lower than our findings: in Uruguay and Italy, 91% and 98%, respectively, whereas in the region of Asturias (Spain), it was 60% (23,24,26).

Special note must be taken of the low participation of medicalized transport by helicopter in Navarra (0.9%), compared to that of France (28.8%) and Italy (36.5%) (23). In our opinion, further investigation on coordination and management of SMIV in Navarra should be undertaken.

In our study, the mean delay in arrival of the first health respondent at the scene of the event was 16 min in NA and 20 min in AP; a result that contrasts with the 9 min reported by the Italian study (23). Pre-hospital assistance time varied, 46 min in NA and 64 min in AP, slightly higher than the 47 min reported by the cited study. It is important to mention that the collection of time intervals in Navarra was low and thus more than 75% of these data were not registered.

As for early notification of the ED, there were significant differences between the two regions; 95.8% in AP and only 59.1% in Navarra, a finding which should be taken into account for further improvement.

Perhaps in some aspects of the management of SMIV there is room for improvement, especially in NA; for example, in the use of cervical collar at the pre-hospital level, which accounts for 76% in PA and 70.2% in NA (although these figures are higher than others: 53.3% in Asturias and 33% in Uruguay), and in the performance of

Table 5. Logistic Regression: Three Models—Age-Sex-Mechanism-RTS-ISS Procedures (Maximum n = 404 cases)

Models	Model 4			Model 5			Model 6		
Variable	OR	95% CI Inferior	95% CI Superior	OR	95% CI Inferior	95% CI Superior	OR	95% CI Inferior	95% CI Superior
Age (years)	1.05	1.03	1.07	1.07	1.03	1.11	1.07	1.03	1.12
Sex	2.15	0.92	5.1	2.65	0.68	10.28	1.98	0.47	8.31
Injury mechanism: penetrating	4.82	1.5	15.6	13.94	2.2	89.15	21.42	2.94	156.27
Injury mechanism: fall	1.22	0.41	3.6	4.64	0.91	23.6	3.99	0.67	23.62
Pre-hospital RTS	0.63	0.53	0.74	0.77	0.58	1.01	0.76	0.55	1.04
ISS on admission ICU				1.07	1.01	1.13	1.04	0.98	1.11
Intubation							1.32	0.31	5.68
Total volume							1.0	1.0	1.0
n	216			114			105		
Cox R^2 and Snell	0.34			0.31			0.29		
−2 log of verosimility	163.1			70.3			63.2		

OR = odds ratio; CI = confidence interval; RTS = Revised Trauma Score; ISS = Injury Severity Score; ICU = Intensive Care Unit.

cervical and pelvis radiography, which was carried out only in 2 of 3 SMIV patients (24,26).

The mean ISS calculated in ICUs showed significant differences in both regions. These differences are probably due to organizational aspects of EDs in France, where there are special units, denominated *dechocage*, which admit critical patients before admission to the ICU. Major trauma patients in NA are admitted to the ICU and thus, possibly present higher severity in RTS and ISS. In the Italian study, the mean ISS reported was 30 and the median 25 (23). Logistic regression showed that for each additional point, the probability of dying increased by 5%. In the Uruguayan study, the mean ISS of those who survived was 12.7 points and 30.6 in those who died (24).

With regard to in situ mortality, no differences were observed—62.3% in AP and 70.2% in NA—data slightly higher than those reported in the Italian study (59.8%) (23). Neither were there significant differences in overall mortality: 54.3% in AP and 49.1% in NA, again slightly higher than reported by the Italian study (45.6%) (23). In AP there were less in situ deaths, although overall mortality was similar or even higher than in NA. This finding raised the question about whether the French trauma system employs more resources in patients with no possibility of surviving (health providers attending SMIV at the scene of the event are more prone to carry out interventions in the field than in NA) or whether patients in AP are really more severe than those seen in NA.

However, significant differences were found concerning deferred mortality during transfer (10.5% in AP and 8.2% in NA) and in the ED (31.6% in AP and 12.2% in NA). This fact suggests the possibility that the French transfer patients with little or no possibility of survival, eventually die in the ED, and therefore, health resources are being used in excess. Also, significant differences were found in the incidence of CPR on admission and during a stay in the ED, with 20 CPRs in AP and 5 cases in NA. Length of stay at the ICU did not differ, with a mean between 9 and 11 days and a median of 4 days, slightly higher than reported in an Australian study (25).

As for the results of comparing the two regions with regard to survival of SMIV, several factors may be included. High mortality rates are present when an emergency system is still scarcely developed and lacks means to rapid access at the scene of the crash involving multiple traumas, and when human resources are not highly qualified and are not capable of offering adequate medical assistance. On the contrary, when the system is developed, the number of patients that survive increases rapidly initially and more slowly later on, up to a point where a plateau is reached, after which a considerable amount of investment in resources is required to achieve a limited increase in survival. We consider that this is the reason why a more sophisticated and developed system, with greater investment in resources and prone to carry out more interventions, as seen in the French model, is unlikely to achieve significant results in survival rates than those obtained in Navarra. In health economic terms, this is known as decreasing marginal productivity (27).

On June 23, 2006, the European Commission presented a paper to the European Parliament and Council regarding actions for a safer Europe (28). The objective was to focus on injury prevention in Europe through public health policies that would assist all member states in giving priority to reducing injuries, with the aim of reducing mortality and morbidity and guaranteeing safety for the citizens of the community. In agreement with this idea, we think that special emphasis should be put on injury prevention rather than on health care investments.

CONCLUSIONS

The employment of more resources and the application of more aggressive treatments, as characterized by the French comprehensive emergency system, does not present higher survival rates in severe multiple injury victims, even when controlling for confusion factors like age, sex, mechanism of injury, RTS, and ISS.

One possible reason why there were no significant differences in the results is because the variables of severity evaluated (RTS and ISS) may not adequately reflect possible differences.

Although more thorough studies have been performed, which serve as references, most attempts at evaluating comprehensive trauma systems are limited by lack of human, technical, and financial resources (29). Our study fits within the possibilities of those with a standard data collection and thus bears both its virtues and defects.

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