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# Pediatric trauma. Epidemiological study among patients admitted to Hospital de Niños "Ricardo Gutiérrez"

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**ABSTRACT**

***Introduction.*** In Argentina, trauma is the most common cause of death among children older than 1 year old, has a high morbidity rate, and results in large costs for the health system.

***Objective.*** To identify causes of injuries in patients admitted to the hospital due to a trauma, and to analyze the relationship between epidemiological factors and severe trauma.

***Population and Methods.*** Prospective study. Children and adolescents aged 0 to 18 years old admitted to the hospital due to unintentional trauma between April 2012 and March 2013 were included.

They were divided into two groups based on severity according to the pediatric trauma score (8 or lower) to identify risk factors by means of a logistic regression model. Predictive outcome measures: patients' and parents' demographic characteristics, socioeconomic factors, event data, initial care, course, and risk factors. Patients were stratified into three age groups for the analysis of the type of injury and the anatomic location.

***Results.*** Two hundred and thirty-seven patients were included. Traumatic brain injuries were predominant among children younger than 3 years old, while limb fractures were most common among children older than 3 years old. In the bivariate analysis, foreign parents, a state of poverty or destitution, an immediate preventable cause, dangerous heights, and an unsafe heating system were statistically significant outcome measures. Based on multiple regression, outcome measures included were foreign parents, living in a slum area, an immediate preventable cause, and an unsafe heating system.

***Conclusions.*** The main cause of trauma was related to falls from heights, and some of the studied socioeconomic factors were associated with a higher risk of trauma. This information may be useful to develop prevention measures.

***Key words:*** *children, unintentional injuries, injuries and trauma, risk factors, prevention.*

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None.

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## INTRODUCTION

One of the first reports on pediatric trauma was back in 1917, during a naval accident in Nova Scotia, which resulted in 3000 killed, 9000 injured, and 30 000 left homeless.[1] Since then, awareness was raised regarding the need to unify knowledge about trauma and apply it in our daily practice. In 1970, Vega-Franco disseminated one of the first epidemiological studies exclusively dealing with accidents in the pediatric population.[2]

Trauma injuries are the main cause of morbidity and mortality among children, adolescents and adults younger than 40 years old, both in developed and in developing countries, causing death in 3 out of 4 injured adolescents. It is estimated that, for every deceased child, 4 to 6 become disabled, and 120 are admitted to hospitals, resulting in a high economic burden on the health system. In Argentina, deaths because of motor vehicle accidents are four times higher than in developed countries when compared to the number of inhabitants or motor vehicles, and this incidence is on the rise.[3,4]

Trauma is defined as any physical damage to the body resulting from the abrupt exposure to forces exceeding the tolerance level, or the lack of warmth or oxygen.[5] It usually occurs under foreseeable circumstances, so it is very important to recognize those settings where prevention measures could be implemented. Being able to identify such circumstances helps to plan prevention strategies,[6] which are more cost effective than a late intervention.[7,8]

Recording and analyzing different types of traumatic events help to

understand the nature and scope of this serious health problem.[9,10]

Hospital de Niños "Ricardo Gutiérrez" is a tertiary care facility with 331 beds; approximately 100 000 patients are seen in its Emergency Department on a yearly basis. Since 1997, it has become the referral Department of Pediatrics for the Trauma and Emergency Network of the Autonomous City of Buenos Aires, with specialists committed to healthcare, research and education in trauma.

## OBJECTIVE

To identify the causes of injury in patients admitted to the hospital because of trauma, and to review the relationship between epidemiological factors and severe trauma.

## POPULATION AND METHODS

This prospective study included patients admitted to the hospital between April 1st, 2012 and March 31st, 2013 with a longitudinal follow-up until discharge.

Inclusion criteria were 1) age: 0 to 18 years old; 2) hospitalization with the diagnosis of trauma. Exclusion criteria: abuse.

If the Pediatric Trauma Score (PTS) was equal or lower than 8, it was considered to indicate a severe trauma at the time of admission, and therefore taken as an outcome measure (endpoint) (see *Annex 1*).

Data prior to the event and about the hospital follow-up were collected. Predictive outcome measures were the patient's demographic characteristics (age in months, sex, nationality and place of residence), parents' demographic characteristics (age, nationality and education), socioeconomic factors (socioeconomic level, health insurance, living in a slum area, home ownership), event data (day of the week, season, place, injury type, PTS at the time of admission, severe PTS at the time of admission and immediate cause), care data (time elapsed until consultation, transfer to the hospital, initial care at other facility, total length of stay, length of stay at the Intensive Care Unit, mechanical ventilation requirement, surgical treatment and social services intervention), risk factors (history of trauma, family violence, drug and alcohol use at home, dangerous heights, unsafe electrical system, dangerous stairs, dangerous window and unsafe heating system), patient course (sequelae and death). Predictive outcome measures were obtained based on secondary data from medical records and interviews to parents conducted by physicians who were part of the study. A form was developed to collect selected data (see *Annex 2*).

In order to identify the anatomic location of injuries, patients were divided into three groups: younger than 3 years old, 3-10 years old, and older than 10 years old.

The study was approved by the hospital Research and Teaching Committee and Ethics Committee. An informed consent was obtained at the time of admission authorizing the performance of any diagnostic and therapeutic procedure.

## STATISTICAL ANALYSIS

Continuous demographic outcome measures are expressed as mean, standard deviation, median and interquartile range; categorical outcome measures, as absolute frequency and percentage. For the bivariate analysis, outcome measures that include the entire population were analyzed and two stratified groups were compared to the endpoint severe PTS at the time of admission (≤8). Continuous outcome measures were compared using a Wilcoxon rank-sum test, and categorical outcome measures, using a chi-square test or Fisher's exact test. A $p<0.05$ was considered significant. Using the magnitude of the association with the endpoint included in the simple regression model, outcome measures were introduced one by one and in a descending order into the multiple logistic regression model. Outcome measures were maintained in the final model if they showed a significant association with the endpoint (0.05 for Wald test) or modified the association by ≥20% (measured as odds ratio [OR]) of any of the model outcome measures.

Model performance was assessed using an area under the Receiver Operating Characteristic (ROC) curve, while its calibration was studied using the Hosmer-Lemeshow test.

## RESULTS

In the study period, 1034 patients were seen at the Emergency Department due to a trauma; 237 (22.9%) were admitted to the hospital and were included in the study. On *Tables 1* and *2*, the population characteristics are described.

In relation to the location of trauma injuries, according to the age stratification, in the first group (<3 years old) the most common injury was traumatic brain injury (TBI): 74% (n= 86), followed by limb trauma (n= 15) and other

locations (n= 16). In the 3-10 year old group, there was a high incidence of limb fracture: 32% (n= 27), TBI (n= 47) and other locations (n= 12). In the >10 years old group, the most common trauma was limb injury (n= 15), spine and intra-abdominal injuries (n= 7, 65%) and TBI (n= 12, 35%).

When comparing severe and non-severe trauma patients, 41.4% (n = 98) were admitted with a PTS ≤8. *Tables 3* and *4* show a comparison between these two groups. Patients with a severe PTS were younger, most frequently had been born to a foreign mother or father, were destitute, and did not have a health insurance. In addition, an immediate preventable cause (recklessness or negligence) and an ineffective or the lack of protection against falls from heights and an unsafe heating system were detected. Patients with a severe PTS also required more complex care and their hospital mortality was higher (3.1% versus 0.7%), although such difference was not statistically significant. Sequelae were more common in the group with a severe PTS when compared to the non-severe group (34.7% versus 18%).

The following results were obtained in relation to socioeconomic risk factors: poverty: 47.7%, destitution: 17.3%, health insurance: 18%, living in a rented house: 64%, living in a slum area: 39.2%, lack of protection against falls from heights: 68%, lack of circuit breaker: 56%, dangerous stairs: 49%, lack of window guards: 65.4%, and an unsafe heating system: 49.4%. In the corresponding simple logistic regression analyses, the following outcome measures showed a positive association with a severe PTS at the time of admission: foreign mother or father (OR: 2.37, 95% confidence interval [CI]: 1.4-4.03), poverty or destitution (OR: 2.09, 95% CI: 1.19-3.68), lack of health insurance (OR: 2.05, 95% CI: 1-4.17), detection of an immediate preventable cause (OR: 3.31, 95% CI: 1.6-6.84), living in a place with dangerous heights (OR: 2.01, 95% CI: 1.13-3.59), and unsafe heating system (OR: 2.11, 95% CI: 1.25-3.58) (*Table 4*).

The final adjusted model consisted of four outcome measures, three positively associated with the endpoint (foreign mother or father, immediate preventable cause, unsafe heating system) and one which showed a negative association (living in a slum area) (*Table 5*).

The model had an average diagnostic performance (area under the ROC curve: 0.69) and an adequate calibration (Hosmer-Lemeshow test, $p$= 0.47). According to the adjusted model,

TABLE 1. *Demographic characteristics (n= 237)*

| | % | n |
|---|---|---|
| **Patient** | | |
| Male | 57.4 | (136) |
| Age (months old), median (interquartile range) | 36 | (19-72) |
| Argentine nationality | 88.6 | (210) |
| Place of residence | | |
| Autonomous City of Buenos Aires | 57 | (135) |
| Greater Buenos Aires Area | 43 | (102) |
| **Mother** | | |
| Age (years old), median (interquartile range) | 28 | (23-36) |
| Foreign nationality | 46 | (109) |
| Education | | |
| Incomplete primary education | 14.3 | (34) |
| Complete primary education | 55.3 | (131) |
| Complete secondary education | 30.4 | (72) |
| **Father** | | |
| Age (years old), median (interquartile range) | 31 | (26-38) |
| Argentine nationality | 57.4 | (136) |
| Education | | |
| Incomplete primary education | 11 | (26) |
| Complete primary education | 56.1 | (133) |
| Complete secondary education | 32.9 | (78) |
| **Socioeconomic factors** | | |
| Poverty or destitution | 65 | (154) |
| Health insurance | 18.1 | (43) |
| Living in a slum area | 39.2 | (93) |
| Home ownership | 36.3 | (86) |

children born to a foreign father or mother have a more than two-fold likelihood of suffering severe trauma than those born to Argentine parents.

Patients for whom an immediate preventable cause (recklessness or negligence immediately before the event) is detected have a more than three-fold likelihood of suffering severe trauma than those for whom there was no immediate preventable cause. Patients living in a house with an unsafe heating system have a two-fold likelihood of suffering severe trauma than those who have a safe heating system. Finally, patients living in a slum area have a lesser likelihood of severe trauma than those who do not.

The most common place where accidents occurred was at home (81%), and the most common mechanism of injury was vertical deceleration (54%) (*Chart 1*).

TABLE 2. *Characteristics of the event (n= 237)*

| **Event data** | **%** | **n** |
|---|---|---|
| **Day** | | |
| Monday through Thursday | 41.2 | (126) |
| Friday | 17.3 | (41) |
| Saturday/Sunday | 29.5 | (70) |
| **Season** | | |
| Summer | 13.5 | (32) |
| Fall | 44.7 | (106) |
| Winter | 23.6 | (56) |
| Spring | 18.2 | (43) |
| **At home** | 81.4 | (193) |
| **Type of injury** | | |
| Physical | 71.3 | (169) |
| Thermal | 10.5 | (25) |
| Foreign body (ingestion) | 9.3 | (22) |
| Other | 8.9 | (21) |
| **Immediate cause** | | |
| Recklessness | 21.9 | (52) |
| Negligence | 55.3 | (131) |
| Other preventable causes | 0.8 | (2) |
| Not preventable | 21.9 | (52) |
| **Pre-existing risk conditions** | | |
| Prior trauma | 15.6 | (37) |
| Family violence | 8.4 | (20) |
| Drug abuse at home | 4.6 | (11) |
| Alcohol abuse at home | 9.7 | (23) |
| Dangerous heights | 67.9 | (161) |
| Lack of circuit breaker | 56.1 | (133) |
| Dangerous stairs | 49 | (116) |
| Lack of window guards | 65.4 | (155) |
| Unsafe heating system | 49.4 | (117) |
| **Data about care delivered** | | |
| Time elapsed until consultation | | |
| <24 hours | 75.1 | (178) |
| 24-48 hours | 13.5 | (32) |
| >48 hours | 11.4 | (27) |
| Transfer to the hospital through prehospital services | 70 | (166) |
| Initial care at a different facility | 20.7 | (49) |
| PTS at the time of admission, median (interquartile range) | 9 | (8-10) |
| Admission to the intensive care unit | 17.3 | (41) |
| Mechanical ventilation | 6.8 | (16) |
| Surgery | 57 | (135) |
| Social services intervention | 31.2 | (74) |
| Total length of stay (days), median (interquartile range) | 4 | (2-7) |
| **Course** | | |
| Death | 1.7 | (4) |
| Severe sequelae | 21.9 | (52) |

PTS: pediatric trauma score.

Analyzing the height of falls in 103 patients, a median height of 1 meter (interquartile range: 1-3, mean: 1.94, standard deviation [SD]: 1.2) was observed in the 55 patients who did not live in a slum area, while a median height of 2.65 meters (interquartile range: 2-3, mean: 2.6, SD: 0.93) was observed in the 48 patients who lived in a slum area. This was a statistically significant difference ($p < 0.01$). In addition, dangerous heights were documented in 86/93 houses in a slum area (92.5%) and in 75/144 houses in non-slum settings (52.1%) ($p < 0.01$), and this difference was more marked in the subset of patients who only suffered a fall (98.1% in a slum area versus 50.2% in non-slum settings).

## DISCUSSION

It is necessary to consider trauma as a disease and to definitely root out its accidental connotation; therefore, research on epidemiological factors related to the causing agent, the host and the environment is required.[11-13]

The purpose of this study is to detect severity related factors in children admitted to the hospital with the diagnosis of trauma, which together with acute lower respiratory tract conditions, accounts for the most common cause of admission to the clinical ward and to the intensive care unit, as reported by other publications.[14,15]

Results obtained show that trauma was predominant among male patients, and children's and parents' median age was consistent with that of other published series.[8] A negative association between the victim's age and trauma severity was observed.[3,4]

Although 89% of patients were Argentine, the parents of more than half of them were also Argentine, while the rest were mostly from other Latin American countries. In the adjusted model, having at least one foreign parent was associated with a severe trauma. Such association may reflect cultural patterns or be a marker of other aspects not covered by this study. This hypothesis has been proposed by Oyetunji, et al. in black patients with no health insurance. Other authors, however,

TABLE 3. *Comparison of patient and care characteristics by pediatric trauma score at the time of admission*

| | PTS ≤8 or severe 41.4% (n= 98) | | PTS >8 or non-severe 58.7% (n= 139) | | |
|---|---|---|---|---|---|
| **Outcome measure** | **%** | **n** | **%** | **n** | **p** |
| **Demographic characteristics** | | | | | |
| Male | 51 | (50) | 61.9 | (86) | NS* |
| Age (months old), median (IQ) | 29.5 | (15-50) | 48 | (22-85) | <0.01† |
| Argentine nationality | 85.7 | (84) | 90.6 | (126) | NS* |
| Place of residence | | | | | <0.01* |
| Autonomous City of Buenos Aires | 67.4 | (66) | 49.6 | (69) | |
| Greater Buenos Aires Area | 32.6 | (32) | 50.4 | (70) | |
| **Data about care delivered** | | | | | |
| Time elapsed until consultation | | | | | NS* |
| <24 hours | 79.6 | (78) | 71.9 | (100) | |
| 24-48 hours | 11.2 | (11) | 15.1 | (21) | |
| >48 hours | 9.2 | (9) | 13 | (28) | |
| Transfer to the hospital | | | | | <0.01* |
| Own means | 11.2 | (11) | 43.2 | (60) | |
| Prehospital service emergency system | 88.8 | (87) | 56.8 | (79) | |
| Initial care at a different facility | 10.2 | (10) | 28.1 | (39) | <0.01* |
| PTS at the time of admission, median (IQ) | 7 | (6-8) | 10 | (9-10) | <0.01* |
| Admission to the intensive care unit | 32.7 | (32) | 6.5 | (9) | <0.01* |
| Mechanical ventilation | 15.3 | (15) | 0.7 | (1) | <0.01‡ |
| Surgery | 55.1 | (54) | 58.3 | (81) | <0.01* |
| Social services intervention | 41.8 | (41) | 23.7 | (33) | <0.01* |
| Total length of stay (days), median (IQ) | 6 | (4-9) | 3 | (2-5) | <0.01† |
| **Course** | | | | | |
| Death | 3.1 | (3) | 0.7 | (1) | NS‡ |
| Severe sequelae | 34.7 | (34) | 13 | (18) | <0.01* |

* Chi square test; † Wilcoxon rank-sum test; ‡ Fisher's exact test.
PTS: pediatric trauma score.

TABLE 4. *Comparison of parents' demographic characteristics, socioeconomic factors, event data and pre-existing risk conditions by pediatric trauma score at the time of admission*

| | PTS ≤8 or severe 41.4% (n= 98) | | PTS >8 or non-severe 58.7% (n= 139) | | | | |
|---|---|---|---|---|---|---|---|
| **Outcome measures** | **%** | **n** | **%** | **n** | **P** | **OR** | **(95% CI)** |
| **Mother's demographic characteristics** | | | | | | | |
| Age (years old), median (IQ) | 27.5 | (23-33) | 28 | (24-37) | NS† | 0.97 | (0.93-1) |
| Foreign nationality | 59.2 | (58) | 36.7 | (51) | <0.01* | 2.5 | (1.47-4.25) |
| Education | | | | | NS* | | |
| Incomplete primary education | 16.3 | (16) | 13 | (18) | | 1 | |
| Complete primary education | 49 | (48) | 59.7 | (83) | | 0.65 | (0.3-1.39) |
| Complete secondary education | 34.7 | (34) | 28.3 | (38) | | 1.01 | (0.44-2.28) |
| **Father's demographic characteristics** | | | | | | | |
| Age (years old), median (IQ) | 30 | (25-37) | 32 | (26-39) | NS† | 0.99 | (0.96-1.02) |
| Foreign nationality | 50 | (49) | 37.4 | (52) | 0.05* | 1.67 | (0.99-2.83) |
| Education | | | | | NS* | | |
| Incomplete primary education | 11.2 | (11) | 10.8 | (15) | | 1 | |
| Complete primaryeducation | 56.1 | (55) | 56.1 | (78) | | 0.96 | (0.41-2.25) |
| Complete secondary education | 32.7 | (32) | 33.1 | (46) | | 0.95 | (0.39-2.33) |
| Socioeconomic factors | | | | | | | |
| Foreign mother or father | 62.2 | (61) | 41 | (57) | <0.01* | 2.37 | (1.4-4.03) |
| Poverty or destitution | 74.5 | (73) | 58.3 | (81) | <0.01* | 2.09 | (1.19-3.68) |
| Health insurance | 12.2 | (12) | 22.3 | (31) | 0.05* | 0.49 | (0.24-1) |
| Living in a slum area | 40.8 | (40) | 38.1 | (53) | NS* | 1.12 | (0.66-1.9) |
| Home ownership | 34.7 | (34) | 37.4 | (52) | NS* | 0.89 | (0.52-1.52) |
| **Event data** | | | | | | | |
| Day | | | | | NS* | | |
| Monday through Thursday | 48 | (47) | 56.9 | (79) | | 1 | |
| Friday | 22.5 | (22) | 13.6 | (19) | | 1.95 | (0.95-3.97) |
| Saturday/Sunday | 29.5 | (29) | 29.5 | (41) | | 1.19 | (0.67-2.16) |
| Season | | | | | NS* | | |
| Summer | 12.2 | (12) | 14.4 | (20) | | 1 | |
| Fall | 40.8 | (40) | 47.5 | (66) | | 1.01 | (0.45-2.29) |
| Winter | 31.6 | (31) | 18 | (25) | | 2.07 | (0.85-5.03) |
| Spring | 15.3 | (15) | 20.1 | (28) | | 0.89 | (0.34-2.31) |
| Type of injury | | | | | <0.01‡ | | |
| Physical | 78.6 | (77) | 66.2 | (92) | | 1 | |
| Thermal | 14.3 | (14) | 7.9 | (11) | | 1.52 | (0.65-3.54) |
| Others (including ingestion) | 7.1 | (7) | 25.9 | (27) | | 0.42 | (0.17-1.04) |
| Immediate preventable cause | 88.8 | (87) | 70.5 | (98) | <0.01‡ | 3.31 | (1.6-6.84) |
| Recklessness | 27.6 | (27) | 18 | (25) | | | |
| Negligence | 61.2 | (60) | 51.1 | (71) | | | |
| Other preventable causes | 0 | (0) | 1.4 | (2) | | | |
| **Pre-existing risk conditions** | | | | | | | |
| Prior trauma | 13.3 | (13) | 17.3 | (24) | NS* | 0.73 | (0.35-1.52) |
| Family violence | 12.2 | (12) | 5.8 | (8) | NS* | 2.28 | (0.9-5.82) |
| Alcohol or drug abuse at home | 15.31 | (15) | 12 | (8.63) | NS* | 1.91 | (0.85-4.29) |
| Dangerous heights | 76.5 | (75) | 61.9 | (86) | 0.02* | 2.01 | (1.13-3.59) |
| Lack of circuit breaker | 62.2 | (61) | 51.8 | (72) | NS* | 1.53 | (0.91-2.16) |
| Dangerous stairs | 52 | (51) | 46.8 | (65) | NS* | 1.24 | (0.74-2.07) |
| Lack of window guards | 68.4 | (67) | 63.3 | (88) | NS* | 1.25 | (0.72-2.4 |
| Unsafe heating system | 60.3 | (59) | 41.7 | (58) | <0.01* | 2.11 | (1.25-3.58) |

* Chi square test; † Wilcoxon rank-sum test; ‡ Fisher's exact test.
OR: odds ratio; 95% CI: 95% confidence interval.
PTS: pediatric trauma score.

have not established such association in terms of race, but they have done so with the lack of health coverage.[16,17]

Some authors have reported a higher rate during the Summer and on weekends, when children do not attend school. This has been attributed to spending more time outdoors, in unsafe places with no adult supervision.[7] However, in our study, the highest number of events occurred during the Fall and on Fridays. A hypothesis to account for such difference may be that the most common injuries in our study were caused by falls from heights and burn wounds, and that risk factors assessed are not related to any particular season.

In relation to the anatomic location of injuries, stratified by age group, there was a higher rate of TBI in the younger than 3 year old group. In these patients, their center of gravity shifts towards their heads and their psychomotor growth is yet incomplete, so they are prone to hitting their heads during a fall, which was the most common mechanism of injury.[18] In the 3-10 year old group, there is an increased incidence of limb fractures because children do not manage to fully straighten up when falling, so they fall on their limbs and also suffer indirect trauma to their chest, abdomen and pelvis.[19] In children older than 10 years old, trauma injuries tend to be similar to those suffered by adults, with a higher frequency of lower limb, spine and intra-abdominal organ injuries.[20]

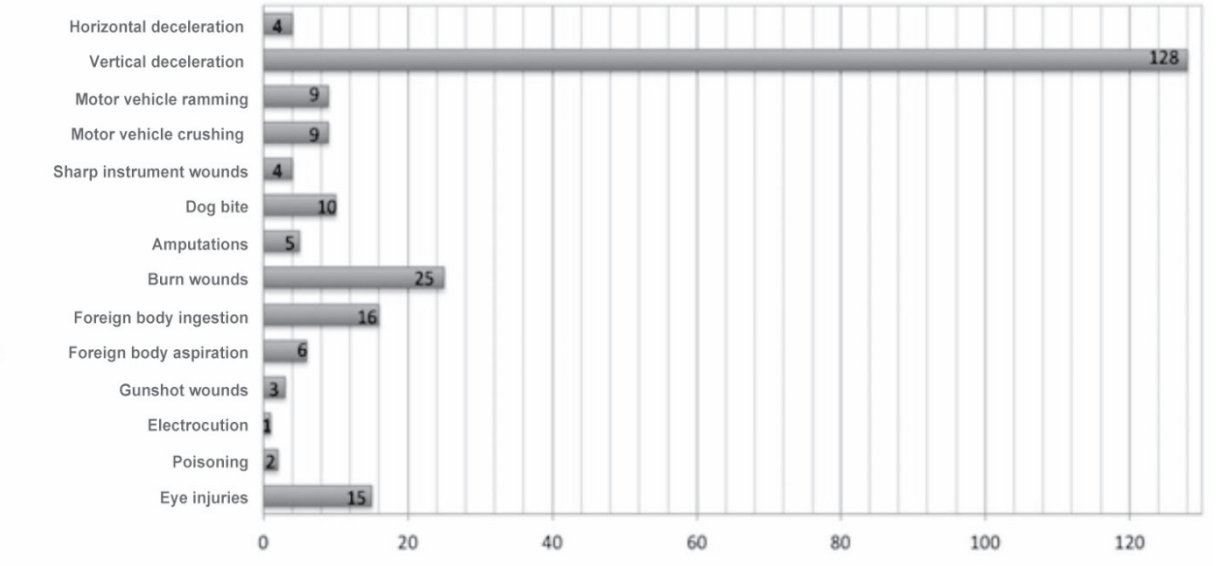
To sum up, the most common injuries were traumatic brain injuries (mostly complicated and/or associated with other anatomic locations) and limb injuries, which is consistent with the literature.[21,22]

The most common place of occurrence was at home, and almost half of the houses had, at least, one dangerous component. However, an

TABLE 5. *Multivariate model to predict the degree of trauma severity at the time of admission at the Emergency Department for patients admitted to the hospital (n= 237)*

| Outcome measure | Odds ratio | 95% confidence interval | | p |
|---|---|---|---|---|
| Foreign mother or father | 2.14 | 1.18 | 3.88 | 0.01 |
| Immediate preventable cause | 3.54 | 1.63 | 7.7 | <0.01 |
| Unsafe heating system | 2.16 | 1.15 | 4.05 | 0.02 |
| Living in a slum area | 0.48 | 0.24 | 0.95 | 0.03 |

CHART 1. *Injury mechanism and type*



unsafe heating system was the only outcome measure associated with trauma severity in the adjusted model, while other risk factors showed no significant association.

In most cases, the event occurred in a circumstance that could have been foreseen immediately before the incident, and this could be considered reckless or negligent care. It is always said that it is very hard to be looking after children 24x7, but creating safe environments for them is not impossible. Although many parents do not see their homes as a risky place for their children, most patients included in this study had suffered a trauma at home, and falls from heights accounted for the main mechanism of injury.

Such behavior was most common among patients with severe trauma, and an immediate preventable cause was observed to have a significant association in the final adjusted model.

Understanding such behavioral pattern helps to reinforce trauma prevention measures and their consequences.[23-26]

In relation to socioeconomic risk factors, there was a high percentage of poor or destitute families who lived in slum areas with no protection against falls on stairs and/or windows. Some authors have established a relationship among a low socioeconomic level, a poor maternal education and a higher risk of severe trauma.[27-29]

In relation to intensive care requirement, 13.5% of patients with a severe PTS were admitted to the Intensive Care Unit.[30] As observed in prior studies,[31] the PTS' discriminating power helped to detect injury severity and tertiary care requirements.

In short, in our population and as a result of a bivariate analysis, having a foreign mother or father, living in poverty or destitution, an immediate preventable cause, lack of health insurance, and an unsafe heating system were statistically significant outcome measures. However, in the multivariate analysis, having a foreign mother or father, immediate preventable cause, and unsafe heating system remained as risk factors for severe trauma, while a negative association was established with living in a slum area. A possible explanation for such association could be a selection bias whereby different reasons, such as, more severe event, delayed emergency services, unavailability, deficient initial care, etc., may lead to increased mortality at the place of occurrence without ever being recorded at the hospital. In addition, the fact that similar percentages were observed for severe and non-severe PTS is probably because the analysis included the overall population (including all causes of trauma) instead of falls from heights exclusively. When considering only falls from heights, the height in meters was significantly higher ($p < 0.01$) in patients who lived in slum areas when compared to those who did not (median: 2.65 versus 1 m), respectively. Another hypothesis is that the presence of outcome measures included in the multivariate model has a confounding effect on the association between severe PTS and living in a slum area, since it does not stand alone from the rest of the studied outcome measures.

The strength of this study lies in the possibility of thoroughly collecting data included in the analysis and of using results to develop a future intervention plan for active prevention.

It should be noted that one of the weaknesses of the study was the difficulty to analyze other major associations, e.g., relationship between falls and living in a slum area, which will be looked into in a future study.

Prevention is the least expensive and most important therapy available to avoid trauma and its complications.[32,33] Several studies agree on the relevance of recording events and the characteristics of varying unintentional trauma events to establish the nature and scope of this increasing problem.[34,35]

In view of the results presented here, we are unhappy to quote the words of an outstanding neurosurgery expert, Prof. Hugo Carrea (1971): *"Traumatic encephalopathy is the most common central nervous system condition during childhood. Although the percentage of mortality and sequelae is not too high, its overall incidence is high enough to call for urgent prevention measures…."*

## CONCLUSION

The main cause of trauma was fall from heights, and some of the socioeconomic factors assessed were associated with a higher risk of trauma. This information may be useful to develop prevention measures. ■

## REFERENCES

1. Stylianos S, Harris BH. The history of pediatric trauma care. En: Buntain WL, ed. *Management of pediatric trauma*. Philadelphia: WB Saunders Co; 1995. Pages 3-9.
2. Baeza-Herrera C, García-Cabello LM, Nájera-Garduño HM, Fernández-Corte MG, et al. Trauma en pediatría. *Bol Med Hosp Infant Mex* 2001;58(8):576-88.
3. Neira J, Bosque L, Zengotita S. Informe estadístico sobre trauma. Buenos Aires: Gobierno de la Ciudad de Buenos

Aires, Sociedad Argentina de Medicina y Cirugía del Trauma, 2000.
4. Iñón AE, Rocca Rivarola M, Herscovici C, Alessandria JC. Morbilidad de los accidentes en pacientes pediátricos y sus familias. *Arch Argent Pediatr* 1993;91(4):202-10.
5. Subsecretaría de Salud Pública, Provincia de Neuquén. Guía de Atención y Cuidado de la Salud de Niños y Niñas de 0 a 6 años. Promoción de la seguridad y prevención de lesiones no intencionales. Neuquén: Ministerio de Salud; 2010. Available at: http://www.saludneuquen.gov.ar/images/archivo/Programas_prov/Guia_de_Atencin_y_Cuidado_del_menos_de_6_anos/Anexo_Prevencion_de_lesiones.pdf. [Accessed: September 10, 2014].
6. Ocampo J, Zima R, Manterola A. Accidentes en la infancia: factores de riesgo. *Arch Argent Pediatr* 1996;94(2):84-9.
7. Bosque L, Neira JA. El término accidente. *Rev Hosp Niños B Aires* 2001;43(191):2-3.
8. Waisman I. Los pediatras argentinos y las lesiones no intencionales en la infancia. *Arch Argent Pediatr* 2002;100(4):275-7.
9. Kemp A, Sibert J. Childhood accidents: epidemiology, trends, and prevention. *J Accid Emerg Med* 1997;14(5):316-20.
10. Zori E, Schnaiderman D. Trauma en la infancia. Estudio epidemiológico en Bariloche. *Arch Argent Pediatr* 2002;100(4):294.
11. Waisman I, Núñez JM, Sánchez J. Epidemiología de los accidentes en la infancia en la Región Centro Cuyo. *Arch Argent Pediatr* 2000;98(1):2-11.
12. Cummins BH, Potter JM. Head injury due to falls from heights. *Injury* 1970;2(1):61-4.
13. Judy K. Unintentional Injuries in pediatrics. *Pediatr Rev* 2011;32(10):431-8.
14. Goonetilleke UK. Injuries caused by falls from heights. *Med Sci Law* 1980;20(4):262-75.
15. Mazurek AJ. Epidemiology of paediatric injury. *J Accid Emerg Med* 1994;11(1):9-16.
16. Oyetunji TA, Stevenson AA, Oyetunji AO, Onguti SK, et al. Profiling the ethnic characteristics of domestic injuries in children younger than age 5 years. *Am Surg* 2012;78(4):426-31.
17. Short SS, Liou DZ, Singer MB, Bloom MB, et al. Insurance type, not race, predicts mortality after pediatric trauma. *J Surg Res* 2013;184(1):383-7.
18. Sawyer JR, Flynn JM, Dormans JP, Catalano J, et al. Fracture patterns in children and young adults who fall from significant heights. *J Pediatr Orthop* 2000;20(2):194-202.
19. Gelfman MG, Ledesma J, Hauier F, Volonté P, et al. Trauma por caída de altura en pediatría. *Arch Argent Pediatr* 2005;103(5):414-9.
20. Hijar-Medina MC, Tapia-Yáñez JR, Lozano-Ascencio R, López-López MV. Accidentes en el hogar en niños menores de 10 años. Causas y consecuencias. *Salud Pública Mex* 1992;34(6):615-25.
21. Haddon W Jr. A logical framework for categorizing highway safety phenomena and activity. *J Trauma* 1972;12(3):193-207.
22. Yagmur Y, Güloğu C, Aldemir M, Orak M. Falls from flat-roofed houses: a surgical experience of 1643 patients. *Injury* 2004;35(4):425-8.
23. Gershanik A. Prevención de accidentes en la infancia. PRONAP 1996. Módulo 2. Buenos Aires: Sociedad Argentina de Pediatría; 1996. Pages 11-30.
24. Schwebel DC, Kendrick D. Caregiver supervision and injury risk for young children: time to re-examine the issue. *Inj Prev* 2009;15(4):217-9.
25. Ruiz-Casares M, Trocmé N, Fallon B. Supervisory neglect and risk of harm. Evidence from Canadian Child Welfare System. *Child Abuse Negl* 2012;36(6):471-80.
26. Morrongiello BA, Zdzieborski D, Sandomierski M, Munroe K. Results of a randomized controlled trial assessing the efficacy of the Supervising for Home Safety program: impact on mothers´ supervision practices. *Accid Anal Prev* 2013;50:587-95.
27. Scholer SJ, Hickson GB, Ray WA. Sociodemographic factors identify US infants at high risk of injury mortality. *Pediatrics* 1999;103(6 Pt 1):1183-8.
28. Kendrick D, Marsh P. How useful are sociodemographic characteristics in identifying children at risk of unintentional injury? *Public Health* 2001;115(2):103-7.
29. Poulos R, Hayen A, Finch C, Zwi A. Area socioeconomic status and childhood injury morbidity in New South Wales, Australia. *Inj Prev* 2007;13(5):322-7.
30. Moreno RP, Araguas JL, Caprotta CG, Lamazares A, et al. Características de la población y aplicación de puntajes pronósticos en una nueva unidad de cuidados intensivos pediátricos. *Arch Argent Pediatr* 2005;103(5):406-13.
31. Tepas JJ 3rd, Ramenofsky ML, Mollitt DL, Gans BM, et al. The Pediatric Trauma Score as a predictor of injury severity: an objective assessment. *J Trauma* 1988;28(4):425-9.
32. Bergman AB, Rivara FP. Sweden´s experience in reducing childhood injuries. *Pediatrics* 1991;88(1):69-74.
33. Lyons RA, Lo SV, Heaven M, Littlepage BN. Injury surveillance in children–usefulness of a centralised database of accident and emergency attendances. *Inj Prev* 1995;1(3):173-6.
34. Morrison A, Stone DH, Doraiswamy N, Ramsay L. Injury surveillance in an accident and emergency department: a year in the life of CHIRPP. *Arch Dis Child* 1999;80(6):533-6.
35. Navascués del Río JA, Vázquez Estévez J. Accidentes en la infancia: los sistemas de trauma. *Rev Esp Pediatr* 1999;55(2):111-6.

# Annex 1

## PEDIATRIC TRAUMA SCORE*

| Component | Score | | |
|---|---|---|---|
| | + 2 | + 1 | - 1 |
| **Height and weight** | Prepubertal or pubertal or adolescent >20 kg | Preschool boy or girl 11-20 kg | Infant ≤10 kg |
| **Airways** | Normal | Assisted with: $O_2$ Face mask | ETT Cricothyrotomy Laryngeal mask |
| **CNS** | Awake, alert and connected | Confused, obtunded Loss of consciousness | Unresponsive Comatose Brain-dead |
| **Systolic blood pressure** | >90 mmHg Good pulses and capillary refill | 51-90 mmHg Palpable carotid and femoral pulses | ≤50 mmHg Weak central pulses or no pulse |
| **Fracture** | None observed or suspected | Single simple fracture at any site | Multiple simple fractures or single open fracture |
| **Skin lesion** | No visible lesions | Contusion/abrasion Laceration <7 cm that does not crosses the fascia | Tissue loss Gunshot wound Sharp injury crossing the fascia |

ETT: endotracheal tube.
CNS: central nervous system.

* Tepas JJ 3rd, Ramenofsky ML, Mollitt DL, Gans BM, et al. The Pediatric Trauma Score as a predictor of injury severity: an objective assessment. *J Trauma* 1988;28(4):425-9.

# Annex 2

## TRAUMA, DAMAGE OR INJURY

First and Last Name:

Medical record number:

DOB: / / Age: Sex: ID no.: Nationality:

Address:

City:

Telephone number: Health insurance:

| | Nationality | Age | Education | Income |
|---|---|---|---|---|
| Mother | | | | |
| Father | | | | |

**Date of admission: - -/- -/- - Date when the event occurred: - -/- -/- -**

**Setting where the event occurred:**

At home
At school
In the streets
Motor vehicle Pedestrian Passenger Bicycle
Playground
Sports club
In the workplace
Others

**Mechanism of injury:**

- Deceleration: Horizontal ☐ Vertical (fall) ☐
- Motor vehicle accident: ☐ Ramming and fall-down ☐ Runvning-over ☐ Crushing ☐
- Wound: Blunt ☐ Sharp ☐ Blunt-sharp ☐ Cut ☐ Scalp ☐
- Sharp instrument ☐
- Gun. Caliber no.: Supersonic ☐ Subsonic ☐
- Multiple round. Shotgun. Caliber no.:
- Pellets ☐
- Blaster ☐
- Laceration ☐ Avulsion ☐
- Burn wound: ☐ Fire ☐ Heat Steam ☐ Fluids ☐
- Frostbite ☐
- Electrocution: domestic electrical grid ☐ High voltage ☐
- Fulguration ☐
- Hypothermia ☐

- Asphyxia: Suffocation ☐ Hanging ☐ Strangulation ☐
- Near-drowning ☐
- Carbon monoxide poisoning ☐
- Poisoning ☐
- Foreign body ingestión ☐
- Foreign body aspiration ☐
- Bites: Dog ☐ Human ☐ Others ☐
- Bites: Insect ☐ Venomous animals ☐

**FALLS: 1) From own height ☐ 2) Free: Clear ☐ Unclear ☐**
**Free-fall. Meters:**

**Landing surface:**

| |
|---|
| Concrete |
| Wood |
| Ground |
| Grass |
| Sand |
| Others |

**Anatomic location of injury:**

| |
|---|
| Central nervous system |
| Head and neck |
| Maxillofacial |
| Spine |
| Limbs |
| Organs |
| Soft tissues |
| Genitourinary |
| Others |

**Cause:**

| | | |
|---|---|---|
| Recklessness | Lack of caution, temperance, moderation and judgment evidenced when acting and speaking. | |
| Negligence | Lack of proper conduct to prevent and avoid the caused damage. | |
| Accidental | Unforeseen, sudden and unpredictable event. | |
| Abuse | | |
| Others | | |

| **Hospital** | **PTS at admission** |
|---|---|
| Initial: | |
| Interim: | |
| Definite: | |

PTS: pediatric trauma score.

| **Transport using public emergency ambulance service** |
|---|
| Private company |
| Own means |
| Others |

**HOSPITALIZATION UNIT:**
**Additional tests:**

**Diagnosis at admission:**

**Treatment:**
Clinical
Surgical (specialty):
Intensive Care Unit (ICU):

| | | |
|---|---|---|
| MV or non-invasive ventilation | YES (days) | NO |
| ICP sensor | YES | NO |

MV: mechanical ventilation.
ICP: intracranial pressure.

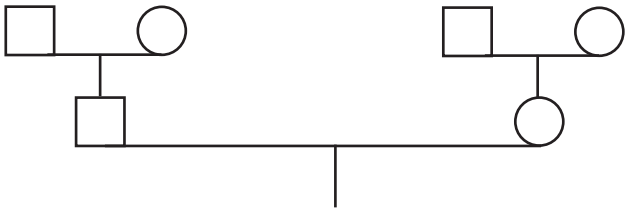
**Total length of stay (days):**

**Date of discharge: - -/- -/- -**

**History of traumatic injuries:**
**Social services intervention:**

| **Risk factors** | **Yes** | **No** | **Describe** |
|---|---|---|---|
| Poverty* | | | |
| Destitution** | | | |
| Drug abuse | | | |
| Alcohol abuse | | | |
| Family violence | | | |
| Own house | | | |
| Protection against heights | | | |
| Circuit breaker | | | |
| Dangerous stairs | | | |
| Window guards | | | |
| Type of heating system | | | |
| Chronic conditions | | | |
| Others | | | |

**Family tree:**



**COMPLICATIONS AND SEQUELAE:**
**REFERENCES**

* Poverty: household income below the total basic basket (TBB), $2990 (Feb. 2012); it includes the basic food basket (BFB) and clothing, transport, education, and health.
** Destitution: household income below the basic food basket (BFB), $1347 (Feb. 2012).

**Definitions**:
Type of injury:
- Physical: injuries caused by movement (kinetic energy exchange);
- Thermal: cold-hot injury;
- Foreign body: ingestion and aspiration;
- Others: gunshot wounds, electrocution, poisoning, eye injuries (Table 2 and Chart 1).

**Immediate cause:**
- Recklessness: lack of caution, temperance, moderation and judgment evidenced when acting and speaking.
- Negligence: lack of proper conduct to prevent and avoid the caused damage.
- Other non-preventable causes: unforeseen, sudden and unpredictable event.
- Other preventable causes: situations that could have been prevented.

Dangerous heights: heights above 1 meter for children younger than 2 years old and above 2 meters for children older than 2 years old, consistent with the bibliography (reference 19).

Unsafe electrical system: system installed by a non-certified electrician, with wiring in plain view or exposed to the elements, saturated electrical grid, lack of circuit breaker.
Dangerous stairs: lack of handrail, no anti-slip material on treads, vertical rise, outdoor stairs.
Dangerous windows: lack of window guards (bars or mesh) or guards that allow children to get their head through.

Unsafe heating system: firewood or coal, lack of balanced draft or any other natural gas heating installed by a non-certified gas fitter.