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Characteristics of injured children attending the emergency department: patients potentially in need of rehabilitation

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Objective: To provide an epidemiological overview of the characteristics of injured children and to compare hospitalized and nonhospitalized injured children to identify predictors of hospitalization and, with that, possible predictors of disablement.
Design: Retrospective analysis of data obtained from a computerized trauma registration system and medical records.
Setting: Department of Traumatology, University Hospital Groningen, the Netherlands.
Subjects: Children (0–19 years) injured in 1996 and 1997 ($n = 5057$).
Results: The majority of children were injured in home and leisure accidents (53%) and sustained minor injuries. Only 55 (1%) children were severely injured (Injury Severity Score (ISS) ≥ 16). Overall, 512 (10%) patients required hospitalization, 19 children were referred to a rehabilitation centre, and 24 children died due to their injuries. The majority of these patients were injured in traffic. Compared with the group of nonhospitalized patients, the group of hospitalized patients consisted of more males and traffic victims, were more severely injured, and sustained more head/neck, spine, and thorax and abdomen injuries. Nonhospitalized patients incurred proportionally more upper and lower extremity injuries. The ISS, the body region of most severe injury, and injury cause (traffic accidents) were significant predictors of hospitalization.
Conclusions: Young traffic victims, severely injured children in terms of high ISS scores, and children with injuries affecting the head/neck/face or thorax/abdomen carry the highest risk of hospitalization.

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Introduction

In most developed countries injuries are the leading cause of death in children and adolescents.[1] Paediatric injuries are responsible for a large number of visits to physicians and emergency departments and result in a substantial number of hospital admissions. In the Netherlands, for instance, each year one of every six children aged 0–14 years is seen by a physician for its injuries, one of every 13 children is treated as an outpatient, and one of every 169 children is hospitalized for accidental injuries.[2]

Various epidemiological studies have investigated the incidence rates of fatal injuries and provided descriptive analyses of these injuries occurring in children and adolescents.[3–5] However, as the number of children that die due to their injuries has decreased in the past decades,[6] the attention needs to be shifted from the fatal cases towards detailed description of the characteristics of the injury survivors.

The rising number of children that survive their injuries will result in an increase of the number of children with residual effects and thereby more injured children will need rehabilitation. Epidemiological studies on paediatric trauma populations are important for rehabilitation medicine as they provide insight into the characteristics of a population at risk of disablement. Since severe injuries probably result in more disabilities compared with minor injuries, the description of the characteristics of severe injuries should receive special attention in an epidemiological study. One of the indicators of injury severity is the need for hospitalization for medical treatment.[7] Only few epidemiological studies have focused on the differences in characteristics between the groups of hospitalized and nonhospitalized injured children.[8,9] Therefore, the purpose of our study is to provide an epidemiological overview of the characteristics of a population of injured children attending the emergency department over a two-year period and, in addition, to compare the groups of hospitalized and nonhospitalized children to identify predictors of hospitalization and with that possible predictors of disablement.

Methods

The study population consisted of all injured children of 0–19 years of age who were treated at the Department of Traumatology of the University Hospital of Groningen between January 1996 and December 1997.

The University Hospital Groningen (1056 beds), in the north of the Netherlands, has a level I trauma centre. Approximately 10 000 injured patients attend the trauma centre for medical treatment every year.[10]

The data used in this study were obtained from a computerized trauma registration system (RLOG) and from medical records. The RLOG (Registratie Letsels en Ongevallen Groningen) is a uniform registration of data on all patients treated at the hospital's Department of Traumatology since 1970. The collected data concerned characteristics of the overall study population, e.g. age, sex, injury diagnoses, the Abbreviated Injury Scale (AIS), the Injury Severity Score (ISS), the body regions of the most severe injury, the injury causes, treatment on an inpatient or outpatient basis and mortality. Additionally, the length of hospital stay and the discharge destination of the patients requiring hospitalization were recorded.

The injury diagnoses were coded according to the International Classification of Diseases (ICD-9CM)[11] and categorized in the body regions defined in the Abbreviated Injury Scale (AIS)[12]: head/neck, face, spine, thorax, abdomen and pelvic contents, upper extremity, lower extremity and external/other. Furthermore, the injuries were grouped into five different diagnostic categories: fractures and dislocations (ICD codes: 800–839), internal injuries (851–854; 860–869; 902), wounds (870–887; 890–897), contusions and sprains and strains (840–848; 920–924), and other injuries.

The severity of an injury was calculated according to the ISS.[13] The ISS is a measure of overall injury severity in persons who have sustained an injury to one or more areas of the body and is computed from the AIS. Patients with an ISS greater than or equal to 16 are generally considered to be severely injured.[14] The ISS scores were categorized into ISS 1–3 (injuries of minor severity), ISS 4–8 (injuries of moderate severity),

ISS 9–14 (serious injuries), and ISS ≥16 (severe injuries).[15,16]

The body region of the most severe injury was defined by the highest AIS score, the maximum AIS (MAIS), and placed in one of the following four categories: head/neck/face, thorax/abdomen, extremities, and other/unspecified. If a subject sustained multiple injuries with identical AIS scores, the MAIS body region was classified regarding the risk of death: head/neck/face > thorax/abdomen > extremities > other/unspecified.[17]

The causes of the injuries, corresponding to the E-codes 800–999 of the ICD-9CM, were categorized into (1) 'traffic accidents' (including all traffic categories, e.g. drivers or passengers of motor vehicles or bicycles and pedestrians), (2) 'home and leisure injuries' (including falls, cutting and piercing injuries, struck by/caught in an object, overexertion, and drowning), (3) 'sports injuries', (4) 'intentional injuries' (including homicides, assaults, suicides and self-destructive actions), and (5) 'other' injuries. For the description of the different road-user groups by age, the children were divided into the following three age groups: 0–3 years of age (pre-school), 4–11 years of age (elementary school), and 12–19 years of age (high school).

A multivariate logistic regression analysis was used (SPSS version 9) to determine predictors of hospitalization after injury and adjusted odds ratios (OR) were calculated to gain insight into the risk of hospitalization. The variables ISS, MAIS and injury cause were entered as independent variables in the logistic regression. Furthermore, continuous and categorical variables were compared using Student's *t*-test and chi-square test, respectively. A *p*-value of ≤0.05 was considered significant.

Results

A total of 5057 patients aged 0 through 19 years were identified. Of this group, 2993 (59%) were males (m:f = 1.5:1). The mean age was 12 years (SD 6) and the number of injured patients increased with age (Figure 1). Home and leisure accidents were the most common cause of injury in the overall study population ($n = 2674$, 53%), followed by sports accidents ($n = 1168$, 23%), traffic accidents ($n = 982$, 19%), intentional

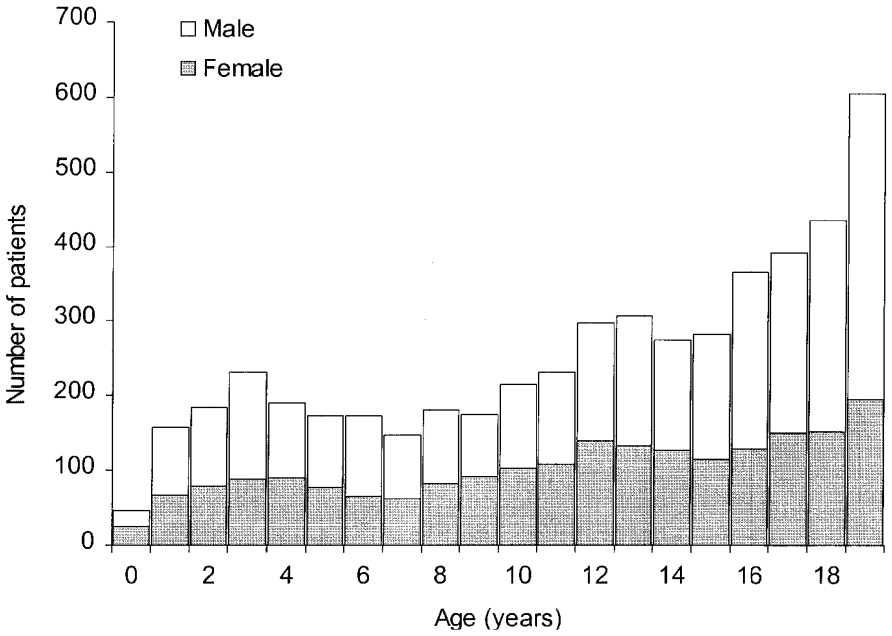

Figure 1 Age and gender distribution in the total study population (n = 5057).

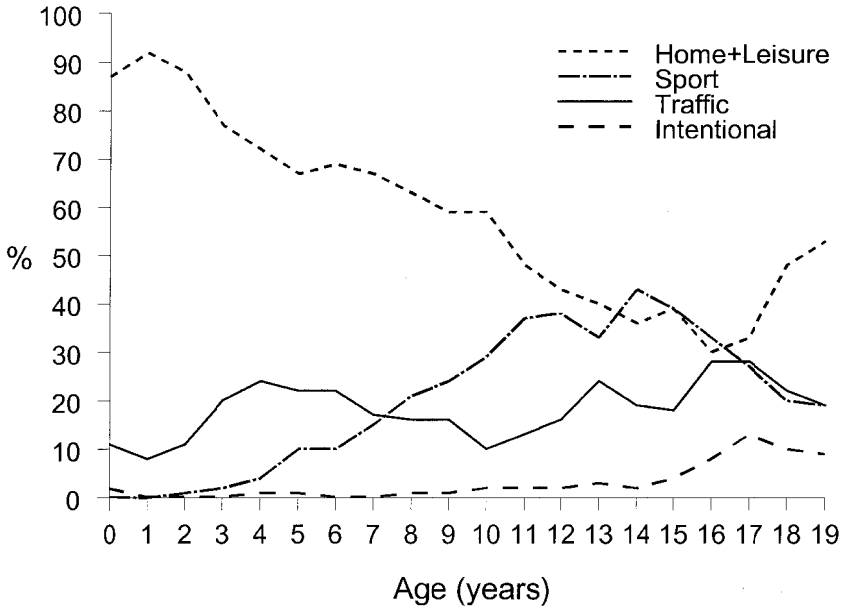

Figure 2 Distribution of the injury causes by age in the total study population (n = 5057).

injuries ($n = 226$, 5%), and other injuries ($n = 7$, 0%).

The causes of injury differed substantially among children at different ages (Figure 2). The proportion of home and leisure accidents far exceeded all other causes of injury in the youngest children. More specifically, the youngest children sustained primarily fall injuries whereas the adolescents were more commonly injured due to cutting/piercing and hit by/caught in an object.

Sports accidents were the number one injury cause in the 14–16 year olds. These children were injured primarily in soccer, organized school sport activities and horse riding.

Traffic-related accidents caused 8% ($n = 12$ one year olds) to 28% ($n = 104$ 16 year olds) of the injuries. Within the category of traffic accidents, bicycle-related accidents predominated in the three different age groups (Table 1). The preschoolers (0–3 year olds) sustained particularly spoke injuries as bicycle passengers ($n = 43$) whereas the older children were injured primarily as bicycle riders. Nearly two-thirds ($n = 305$, 62%) of the bicycle riders incurred a single-bicycle crash (without a collision with another road-user), and 27% ($n = 133$) were injured due

Table 1 Traffic accidents: road-user categories for the three different age groups

Categories of road users	0–3 years	(%)	4–11 years	(%)	12–19 years	(%)	All children	(%)
Motor vehicle driver	0		1	(0)	19	(3)	20	(2)
Motor vehicle passenger	15	(18)	23	(9)	41	(6)	79	(8)
Moped rider	0		3	(1)	177	(27)	180	(18)
Bicyclist	11	(13)	128	(51)	352	(55)	491	(50)
Bicycle passenger	49	(58)	60	(24)	6	(1)	115	(12)
Pedestrian	8	(10)	33	(13)	18	(3)	59	(6)
Other	1	(1)	4	(2)	33	(5)	38	(4)
Total	84	(100)	252	(100)	646	(100)	982	(100)

to a collision with a motor vehicle.

The proportion of intentional injuries increased with age and occurred primarily in the older teenagers.

The mean ISS of our study population was 2 (SD 4, median 1, range 1–75) and the great majority of the patients had an ISS equal to or less than 4 ($n = 4740$, 94%). Only 55 (1%) of the patients were severely injured (ISS ≥16) and the majority of these patients sustained their injuries in traffic ($n = 42$, 76%).

Twenty-four patients died due to their injuries. These nonsurvivors had a mean ISS score of 44 (SD 22, median 37, range 17–75) and were primarily injured in traffic accidents ($n = 16$, 67%): as bicyclists ($n = 6$), motor vehicle passengers ($n = 4$), pedestrians ($n = 4$) and moped riders ($n = 2$). Furthermore, children died due to drowning ($n = 3$), fall ($n = 2$), hit by an object ($n = 1$), suicide ($n = 1$), and one child was run over by a fork-lift truck. The causes of death were the following: severe brain injuries ($n = 16$, 67%), uncontrollable bleeding ($n = 3$), drowning ($n = 3$), transection of the cervical spinal cord ($n = 1$), and one unknown cause.

Hospitalized versus nonhospitalized patients

Of the 5057 patients, 512 (10%) were hospitalized directly after the injury. On average, these patients stayed in hospital for 8 days (SD 10, median 3, range 1–69 days). More than one-third of the patients were hospitalized for 1 or 2 days ($n = 190$, 37%). Furthermore, an additional 35 patients were hospitalized at a later stage due to malunion ($n = 10$), infections ($n = 7$), secondary diagnostic interventions (arthroscopy of the knee) and postponed treatment ($n = 6$), missed diagnoses ($n = 4$), skin covering problems ($n = 4$) and other causes ($n = 4$). For the further analyses these 35 patients were considered to be outpatients.

The group of hospitalized patients consisted of more males ($n = 334$, 65% versus $n = 2659$, 59%; $p = 0.003$) and sustained proportionally more injuries in traffic accidents than the group of nonhospitalized patients ($n = 201$, 39% versus $n = 781$, 17%; $p < 0.001$). Furthermore, they had significantly higher ISS scores than their nonhospitalized counterparts (mean ISS 8 versus mean ISS 2; $p < 0.001$).

The injury profiles were different for the hospitalized and nonhospitalized patients. The group of hospitalized patients ($n = 1005$ injury diagnoses) sustained proportionally more injuries to the head/neck ($n = 169$, 17% versus $n = 82$, 2%; $p < 0.001$), spine ($n = 20$, 2% versus $n = 25$, 1%; $p < 0.001$), thorax ($n = 57$, 6% versus $n = 53$, 1%; $p < 0.001$), and abdomen and pelvic contents ($n = 63$, 6% versus $n = 76$, 1%; $p < 0.001$) compared with the group of nonhospitalized patients ($n = 5305$ injury diagnoses). The nonhospitalized patients, on the other hand, sustained significantly more injuries to the upper extremities ($n = 2374$, 45% versus $n = 254$, 25%; $p < 0.001$) as well as to the lower extremities ($n = 1633$, 31% versus $n = 267$, 27%; $p = 0.008$). More specifically, considering the specific injury types within the body regions (Table 2), fractures and dislocations of the head/neck, face, spine, and upper and lower extremities were more frequently present among the group of hospitalized than the group of nonhospitalized patients (all p-values < 0.001). Furthermore, significantly more hospitalized patients sustained internal injuries of the head ($p < 0.001$), and abdomen and pelvic contents ($p < 0.001$), and all internal injuries of the thorax were hospitalized. Of note is the large proportion of the so-called 'other injuries' of the head/neck among the nonhospitalized patients compared with the hospitalized patients ($p < 0.001$). These injuries concerned concussions with no, very brief or unspecified loss of consciousness.

The majority of the hospitalized patients were discharged home ($n = 459$, 94%) and only a small proportion of the patients were admitted to a rehabilitation centre or discharged to a hospital nearer to their residence ($n = 19$ and $n = 10$, respectively).

The variables ISS, MAIS and injury cause (traffic accidents versus other) were significant predictors of hospitalization (Table 3). With an increase in the ISS score, the likelihood of hospitalization increased notably. Furthermore, MAIS head/neck/face and MAIS thorax/abdomen were associated with the highest risk of hospitalization compared with the other body regions. More specifically, patients with MAIS thorax/abdomen carried the highest risk of hospitalization: they were 4.8 times more likely to be hospitalized than patients with MAIS

Table 2 Injury profiles of the hospitalized and nonhospitalized patients

Body region		Fractures + dislocations (%)	Internal injuries (%)	Wounds (%)	Contusions + sprains (%)	Other injuries (%)	Total (n)
Head/neck	H	19	36	1	–	44	169
	NH	1	1	2	–	95	82
Face	H	25	–	48	15	13	158
	NH	1	–	73	19	8	932
Spine	H	100	–	–	–	–	20
	NH	8	–	–	88	4	25
Upper extremity	H	66	–	12	7	15	254
	NH	35	–	25	35	6	2374
Lower extremity	H	59	–	15	12	14	267
	NH	17	–	13	62	8	1633
Thorax	H	11	53	4	23	11	57
	NH	9	–	8	64	19	53
Abdomen	H	–	57	10	32	2	63
	NH	–	11	11	78	1	76

H, hospitalized patients (overall n = 1005 diagnoses); NH, nonhospitalized patients (overall n = 5305 diagnoses).
The category external/other injuries is not included in the table.

Table 3 Multiple logistic regression analysis of predictors of hospitalization

Predictors of hospitalization[a]	Number (total = 5057)	Adjusted odds ratio	95% CI	*p–value*
MAIS				*p < 0.001*
Head/neck/face	967	10.1	(1.2–87.7)	
Thorax/abdomen	175	48.4	(5.4–432.6)	
Extremities	3826	4.0	(0.5–34.1)	
ISS				*p < 0.001*
4–8	1227	12.9	(9.8–17.0)	
9–14	137	178.3	(106.2–299.4)	
≥16	53	–[b]	–	
Injury cause				*p < 0.05*
Traffic	982	1.4	(1.1–1.8)	

[a]Reference categories: MAIS other/unspecified, ISS 1–3, and 'other accidents'.
[b]All patients with an ISS ≥ 16 were hospitalized and odds ratios could not be determined.
MAIS, Maximum Abbreviated Injury Scale; ISS, Injury Severity Score.

head/neck/face (adjusted odds ratio (OR) 4.8, 95% confidence interval (CI) 2.9–7.8). Patients injured in traffic were 1.4 times more likely to be hospitalized than patients who sustained their injuries in other accidents.

Discussion

Injuries are not only the leading cause of death in children but also a major source of disabilities. For a full understanding of the magnitude and the extent of the injury problem in children information on both the epidemiology of paedi-

Clinical messages

- The outcome of paediatric injuries in terms of disabilities needs more attention. In such studies nonhospitalized children with extremity and head injuries should be included.
- Children with traffic-related injuries are at high risk of residual disability and are in need of rehabilitation.
- Single-bicycle accidents seem an unrecognized but important injury cause for children.

atric injuries as well as information on the impact of injuries on the child's life, their family and on society are needed. We conducted an epidemiological study in order to provide insight into the injury patterns and the most prevailing injury causes of children attending an emergency department with injuries ranging from minor severity through life-threatening injuries. The current epidemiological overview illustrates the context from which disabilities arise and these data are essential for the interpretation and design of outcome studies.

The majority of epidemiological studies on childhood injuries have limited their field of study to specific subpopulations of injured children. Some of these studies have focused primarily on hospitalized children,[18,19] very severely injured children,[20–22] specific injury types such as fractures[23,24] or on specific injury causes such as traffic-related accidents.[25–27] However, for an accurate view on the injury problem in children, the focus should not be on a specific selection of injuries but on all injuries including those of minor severity, as was the aim of our study.

Epidemiological studies are difficult to compare since many different definitions, categories of injury causes, and methods of data collection are used. Nevertheless, some general remarks can be made. Overall, home and leisure accidents caused most of the injuries in our study population as reported in other studies.[8,28] The great majority of these injuries were of minor severity and few of these injuries required hospitalization, which is consistent with previous findings.[8,29] In the younger children (1–12 years of age) more than half of the home and leisure accidents concerned falls. As young children develop their motor and perceptual skills they often fall downstairs and during running and jumping. To decrease the number of these injuries continuous supervision of young children who explore their home environment is necessary, but impossible in practice. Home safety measures, such as stairway gates, are very important and often easy to apply.[30]

Compared with the injuries caused by home and leisure accidents, traffic-related injuries occurred less often but were more severe. Traffic accidents proportionally led to most of the hospitalizations, referrals to rehabilitation centres, and caused the majority of deaths. As traffic victims often incur serious injuries these patients are at high risk of residual disability and are to a high degree in need of rehabilitation. The traffic victims of our study sustained predominantly bicycle-related injuries. The high incidence of bicycle injuries reflects the popularity of cycling, for transportation and recreational purposes, in the Netherlands. Although collisions with motor vehicles often result in very serious and fatal injuries, our finding that more than half of the bicycle riders were injured in single-bicycle crashes, including falls from the bicycle and collisions with stationary objects, implies that more attention should be paid to the latter group.

The hospitalization rate found in our study comprised 10% which seems relatively high compared with previously reported rates (2–9%).[8,28,31,32] This difference may partly be caused by the fact that severe brain injuries are preferably treated in our Trauma Centre compared with the surrounding hospitals. The guidelines concerning hospitalization vary among hospitals in the Netherlands. In our hospital all children who need anaesthesia for medical treatment are hospitalized, even for a short anaesthetic treatment. More than one-third of the patients of our study population were hospitalized for a period of only one or two days. These patients primarily sustained fractures of the extremities and were hospitalized for anaesthetic reasons or they sustained head injuries and were hospitalized for observation purposes. Recent studies on minor head injuries in children have indicated that routine hospitalization is not

always warranted.[33–35] A number of children with minor head injuries can be safely observed at home by a reliable caretaker who has been instructed to observe the child properly and to evaluate potential complications. As hospitalization may have adverse emotional effects on the child, unnecessary hospitalization should be avoided. Therefore, more studies are needed to investigate if certain subgroups of injured patients may be treated safely as outpatients.

Of the total of 5057 injured children who were evaluated in this study, only 24 died as a consequence of their injuries. In view of the few deaths, the outcome in terms of mortality, which has been a subject of many studies,[18,36,37] seems to be of limited value. Outcome of nonfatal injuries in terms of disabilities needs more attention. A shortcoming of our study is that it does not include an outcome assessment of the injuries. However, on the basis of our data and with respect to the identified predictors of hospitalization we can make some remarks regarding subgroups of children at risk of disablement. The present study demonstrated that the ISS, the injury cause, and the MAIS are significant predictors of hospitalization. More specifically, children injured in traffic, children with severe injuries in terms of high ISS scores, and children with injuries affecting the head/neck/face or thorax/abdomen carry the highest risk of hospitalization. Subsequently, the question arises whether these children are also at a high risk of sustaining injury-related disabilities. It is known that severe injuries to the thorax or the abdomen and pelvic contents are often life-threatening and characterized by high ISS scores, yet, these injuries rarely result in disabilities.[38,39] Rather, injuries to the head, spinal cord or extremities which are not always assigned with high ISS scores are much more likely to cause residual deficits. Since a large number of patients with extremity injuries were treated on an outpatient basis, it is likely that in addition to the hospitalized patients a substantial number of nonhospitalized patients in our study population may have suffered injury-related disabilities as well. In addition to the ISS which fails to correlate closely with disabilities,[38,40] the need for hospitalization seems to be a poor predictor of disabilities as well. In our opinion future studies on the impact of paediatric injuries should not be limited to hospitalized and very severely injured children in terms of high ISS scores, but should also take nonhospitalized patients, in particular those with minor head or extremity injuries, into account.

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