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A retrospective cohort study of suspected child maltreatment cases resulting in hospitalization

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ABSTRACT

Objectives: Although the incidence and risk factors of child abuse have been well researched, there continues to be a need for large studies that provide information regarding the process of recognizing children whose health and lives are most seriously threatened by abuse and neglect, in particular children requiring hospitalization as a result of child abuse. The purpose of this study was to (1) describe differences in the type of injuries and illnesses of children hospitalized for abuse and neglect and (2) assess the relationship between in-hospital mortality and child maltreatment.
Methods: For this retrospective cohort study, child maltreatment cases were identified using medical record databases of patients treated in all hospitals and trauma units in Illinois. A comparison group of children not suffering from suspected maltreatment were randomly selected and matched by age and data source to the suspected maltreatment cases.
Subjects: 2656 children under the age of 13 years suspected of suffering maltreatment who were admitted to any hospital in Illinois between 2000 and 2009.
Results: The analysis showed distinct patterns in injury, physical illness and psychological disorders for each subgroup of maltreatment cases. Among the cases of maltreatment 75.6% were discharged home, 2.9% into child protective services and 15.8% to an intermediate care facility. In the final multivariable conditional logistic regression model, children suffering maltreatment continued to have a higher odds of dying during hospitalization (adjusted OR = 2.99; CI95%: 1.63, 5.45; $p < 0.001$).
Conclusion: There were distinct diagnostic patterns and outcomes among suspected cases of child maltreatment admitted to Illinois hospitals over a 10-year period. This large retrospective cohort study confirms findings reported in many smaller studies and larger national cross-sectional surveys.
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Introduction

Abuse of children using infanticide, mutilation, and abandonment has been in evidence since ancient times.[1] In the first three centuries some doctors felt that if a child was not perfect in every way, infanticide was acceptable. Soranus, a leading Greek medical figure, wrote a guide on "How to Recognize the Newborn who is Worth Rearing".[2] In the nineteenth century, evidence of child maltreatment cases began to emerge in medical papers describing injuries in children that consisted of fractures, suffocation, and burns.[2,3]

In the 1970s the United States first began compiling data on child abuse and neglect.[3] There was an estimated 669,000 cases in 1976, and by 1997 the annual reported cases of child abuse and neglect had increased to 3.2 million.[3] However, the escalation in reported cases, to a large degree, is attributable to changes in the definition of maltreatment, and better recognition and reporting by clinicians and other mandated reporters.[3]In the United States it is believed that nearly 12 out of every 1000 children annually are affected by child maltreatment, with the largest concentration of suspected cases occurring among children under the age of three.[4] Additional literature suggests that a child who lives in a home where domestic violence occurs is 6–15 times more likely to be abused by either parent/guardian.[3] In addition, the peer reviewed literature has identified the following risk factors for physical child abuse: premature birth, being a twin, a child under 18 months old, excessive crying by the child, hyperactivity, having a young mother, a history of abuse in the primary caregiver, parental substance abuse, domestic violence in the home, and a lack of family and social support.[5–8]

However, there continues to be a need for studies that provide information regarding the process of recognizing children whose

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health and lives are most seriously threatened by abuse and neglect, in particular children requiring hospitalization as a result of child maltreatment. Large studies that describe broad constellations of shared comorbidities, diagnoses and outcomes within and between different groups of maltreated children admitted to hospitals would help clinicians both recognize and treat maltreated children. This study analyzes data on children admitted to hospitals in Illinois for child maltreatment. The cases were identified using hospital databases, which provide a unique opportunity to evaluate a large subset of children suffering maltreatment that results in hospitalization. The main objectives of this study are to (1) describe differences in the type of injuries and illnesses between subgroups of maltreated children and (2) assess whether in-hospital mortality was higher in maltreated children as compared to controls.

Methods

Data sources

We conducted a retrospective cohort study using two State of Illinois medical record databases: the Illinois trauma registry and the Illinois hospital discharge dataset. We received data for years 2000–2009 for both datasets. The University of Illinois at Chicago institutional review board approved this research (approval #2012-0116).

Illinois trauma registry

The Illinois trauma registry (ITR) is mandated by the state legislature and is managed by the Illinois Department of Public Health. All of the State's level 1 and 2 trauma centres ($N = 62$) are required to report all patients (1) sustaining traumatic injuries (ICD-9-CM external injury codes E800-995) and admitted to a trauma centre for >12 h, (2) transferred to a level I or II centre or (3) are dead-on-arrival (DOA) or die in the emergency department. We provided an assessment of data quality of the ITR in a previous paper of ours.[9] The ITR contains data on demographics (age, gender, race/ethnicity), exposure (mechanism of injury), and health outcomes (diagnoses, measures of injury severity, hospital procedures, disability status on discharge), and economics (payer source).

Hospital discharge database

The University of Illinois at Chicago Hospital is a member of the Illinois Hospital Association, the organization that compiles and manages the hospital discharge database. As a member of the Illinois Hospital Association, the PI's research team has ongoing access to the hospital discharge database. The hospital discharge database is based on billing records. It includes all patients treated for more than 23 h in any Illinois hospital (i.e. inpatients only) for any medical reason. The hospital discharge database includes variables on patient demographics (age, gender), exposure (mechanism of injury), health outcomes (diagnoses, hospital procedures, discharge status), and economics (hospital charges, payer source). The Illinois Hospital Association compiles, maintains, and conducts quality control of the dataset.

Inclusion criteria

The study included children under the age of 13 years admitted and treated in Illinois hospitals. The following criteria were used to identify cases of child maltreatment: (1) patients with a perpetrator E967 ECODE (ICD-9-CM code) designating physical abuse, shaken infant syndrome, sexual abuse, emotional and psychological abuse, neglect, and unspecified abuse and (2) patients with a 995.80-.85 NCODE (ICD-9-CM code) designating abuse and neglect. To be coded as a case, a member of the treating medical staff had to recognize the maltreatment and document it. Cases from the two State databases were merged and deduplicated.

Selection of the comparison group (unexposed)

For the comparison group, we selected from a list of all patients under the age of 13 without indication of maltreatment included in the trauma registry and hospital discharge dataset between 2000 and 2009. We randomly sampled one child without any indication of maltreatment for each case of maltreatment matching by age and dataset of origin (trauma registry and hospital discharge) using the random sampling procedure in SAS (PROC SURVEYSELECT). The mean difference in age between pairs was 18 days, with a maximum difference of 110 days. The matching criteria also ensured that there were equal number of exposed and unexposed cases treated in hospitals with specialized trauma care facilities.

Descriptive analysis

Cumulative proportions and prevalence of demographic characteristics, place, and severity of injury are described for cases of maltreamtent and the comparison group. The cases of maltreamtent were also stratified by the following types of maltreatment based on ICD-9-CM coding: physical abuse, shaken infant syndrome, sexual abuse, emotional and psychological abuse, neglect, and unspecified abuse. ICD-9-CM NCODES were used to assess body region and type of injury based on the Barell classification matrix.[10] The new injury severity score (NISS) was used in this analysis, and differs from the traditional formulation in that it uses the sum of the squares of the three highest abbreviated injury scores (most severe injuries) regardless of body region.[11,12] NISS scores are based on all NCODES for injuries identified during the course of hospitalization and have been shown to be a better predictor of adverse outcomes than the traditional formulation.[12] We use the cut-off of NISS $\geq$ 16 to identify individuals suffering major injuries that are serious, severe and life threatening.[13,14]

Each patient in the trauma registry has up to 25 ICD-9 diagnosis codes listed in their record and these were used to calculate the Charlson Comorbidity Index[15] and evaluate trauma complications. We identified trauma complications associated with increased in-hospital mortality which include: general complications with ICD-9-CM codes of 958–959, poisoning during the course of medical treatment, acute posthemorrhagic anaemia, cerebral oedema/anoxia/encephalopathy, hypotensive shock, pulmonary insufficiency as a result of trauma, acute respiratory failure, and septicemia.

Statistical analysis

We used SAS software for all statistical analyses (v.9.1; SAS Institute Inc., Cary, NC). We used McNemar chi-square tests for analysis of categorical variables, and the paired *t*-test for assessing continuous variables. The primary outcome of interest for the multivariable analysis was in-hospital mortality of patients. Deaths occurring prior to arrival at the trauma centre and those occurring following failed resuscitation during the initial assessment were not used to calculate the in-hospital mortality. A multivariable conditional logistic regression model was developed to evaluate the relationship between hospitalization for child maltreatment and in-hospital mortality, and the final model was selected using the maximum likelihood statistical method (similar to manual stepwise model building). Odds ratios are presented, including the 95% confidence intervals. The final

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Table 1
Demographic characteristics, measures of severity and reasons for hospitalization among suspected child maltreatment cases resulting in hospitalization in Illinois, 2000–2009.

	Child physical abuse ($N=1525$)	Shaken infant syndrome ($N=430$)	Child neglect ($N=350$)	Child emotional & psychological abuse ($N=12$)	Child sexual abuse ($N=166$)	Child abuse, unspecified ($N=173$)	Maltreatment cases ($n=2656$)	Comparison group[a] ($n=2656$)	p-Value[*]
Gender									
Female	646 (42.4%)	137 (31.9%)	138 (39.4%)	7 (58.3%)	121 (72.9%)	84 (48.6%)	1133 (42.7%)	1080 (40.7%)	0.146
Male	879 (57.6%)	293 (68.1%)	212 (60.6%)	5 (41.7%)	45 (27.1%)	89 (51.4%)	1523 (57.3%)	1576 (59.3%)	
Age									
Under 1 years	744 (48.8%)	369 (85.8%)	158 (45.1%)	2 (16.7%)	1 (0.6%)	70 (40.5%)	1344 (50.6%)	1344 (50.6%)	–
1 years old	238 (15.6%)	61 (14.2%)	61 (17.4%)	0 (0.0%)	13 (7.8%)	26 (15.0%)	399 (15.0%)	399 (15.0%)	
2 years old	176 (11.5%)	0 (0%)	28 (8.0%)	0 (0.0%)	13 (7.8%)	10 (5.8%)	227 (8.5%)	227 (8.5%)	
3 years old	97 (6.4%)	0 (0%)	23 (6.6%)	1 (8.3%)	11 (6.6%)	13 (7.5%)	145 (5.5%)	145 (5.5%)	
4 years old	56 (3.7%)	0 (0%)	18 (5.1%)	0 (0.0%)	21 (12.7%)	11 (6.4%)	106 (4.0%)	106 (4.0%)	
5–6 years old	85 (5.6%)	0 (0%)	20 (5.7%)	1 (8.3%)	17 (10.2%)	12 (6.9%)	135 (5.1%)	135 (5.1%)	
7–9 years old	78 (5.1%)	0 (0%)	21 (6.0%)	3 (25.0%)	37 (22.3%)	10 (5.8%)	149 (5.6%)	149 (5.6%)	
10–12 years old	51 (3.3%)	0 (0%)	21 (6.0%)	5 (41.7%)	53 (31.9%)	21 (12.1%)	151 (5.7%)	151 (5.7%)	
Hospital treatment									
Mean days in hospital	6.80 (sd = 10.40)	13.55 (sd = 13.47)	9.25 (sd = 13.67)	8.29 (sd = 6.58)	10.78 (sd = 15.78)	7.44 (sd = 12.99)	8.51 (sd = 12.22)	3.16 (sd = 6.13)	<0.001
Required mechanical ventilation	197 (12.9%)	160 (37.2%)	15 (4.3%)	0 (0.0%)	5 (3.0%)	19 (11.0%)	396 (14.9%)	100 (3.8%)	<0.001
Required surgical intervention	288 (18.9%)	154 (35.8%)	32 (9.1%)	0 (0.0%)	19 (11.4%)	36 (20.8%)	529 (19.9%)	472 (17.8%)	0.046
In-hospital fatalities	58	43	0	0	2	8	111	22	<0.001
In-hospital case fatality rate	3.80%	10.00%	0.00%	0.00%	1.20%	4.60%	4.18%	0.83%	<0.001
Acute injury									
Acute traumatic injuries	1366 (89.6%)	336 (78.1%)	49 (14.0%)	3 (25.0%)	33 (19.9%)	0 (0.0%)	1787 (67.3%)	1001 (37.7%)	<0.001
Penetrating injuries	5 (0.3%)	0 (0.0%)	1 (0.3%)	1 (8.3%)	3 (1.8%)	0 (0.0%)	10 (0.4%)	45 (1.7%)	<0.001
Mean new injury severity score	12.26 (sd = 12.54)	24.49 (sd = 14.65)	6.45 (sd = 8.39)	3 (sd = 1.00)	6.09 (sd = 8.38)	–	14.3 (sd = 13.8)	7.16 (sd = 6.92)	<0.001
NISS 16+ (serious injury)	448 (29.4%)	292 (67.9%)	7 (2.0%)	0 (0.0%)	4 (2.4%)	0 (0.0%)	751 (28.3%)	120 (4.5%)	<0.001

[*] p-Value – McNemar chi-square test for categorical variables; paired t-test for continuous variables.
[a] Comparison group-random selection from a list of all patients under the age of 13 without indication of maltreatment. Matched with cases by age and dataset of origin (trauma registry and hospital discharge).

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multivariable logistic regression models included the following covariates: gender (dichotomous), number of hospitalization days (Length of Stay; continuous), use of mechanical ventilation (dichotomous), need for surgical intervention (dichotomous), new injury severity scores indicating serious injuries (NISS $\geq$ 16; dichotomous), acute injury (yes/no; dichotomous) and complications associated with increased mortality in trauma patients. No evidence of multicolinearity among the independent variables was indicated. A two-sided p-value less than 0.05 was considered statistically significant.

Results

Demographic characteristics of the cases of maltreamtent and the comparison group are presented in Table 1. Suspected maltreatment cases included 1523 males and 1133 females, with a similar distribution among the comparison group. The comparison group were admitted primarily for diseases (N = 1655; 62.3%), and injuries caused by falls (N = 588; 22.1%), motor vehicle crashes (N = 80; 5.0%) and being struck or caught between objects (N = 55; 2.1%). Among cases of maltreatment, half were infants under the age of one (N = 1344; 50.4%).

The father, stepfather, boyfriend, or male partner of the child's parent or guardian was the most commonly identified perpetrator of abuse and neglect (18.5%), while key females such as the mother, stepmother, girlfriend, or female partner of child's parent or guardian were identified as the perpetrator in 11.2% of the cases. An additional 9.1% of the cases were abused or neglected by other relatives such as siblings, grandparents and others. Non-related caregivers were identified as the perpetrators in only 2.2% of the cases. In a majority of the cases of abuse and neglect (59.0%), the perpetrator was not specified.

The mean hospital stay was more than twice as long among cases of maltreatment as compared to the unexposed group ($p < 0.001$) (Table 1). Maltreatment cases were more likely than the comparison group to be placed on ventilators ($p < 0.001$), but were only slightly more likely to require surgical intervention ($p = 0.046$). The in-hospital case fatality rate was substantially higher among maltreatment cases as compared to the unexposed group (4.18% vs. 0.83% respectively; $p < 0.001$), and the difference in in-hospital case fatality rates remained when stratified by children admitted for acute injuries (5.37% cases vs. 1.10% controls; $p < 0.001$) and diseases only (1.73% cases vs. 0.66% controls; $p < 0.001$). Among the cases of maltreatment and the comparison group admitted for acute injuries, the mean new injury severity score was 2-fold greater in cases of maltreatment compared to the unexposed group, and the proportion of cases with serious injuries (NISS $\geq$ 16) was more than 5-times that of comparison group (Table 1). Among the maltreated children, the measures of severity in terms of hospital stay, requiring mechanical ventilation and the proportion of serious injuries (NISS 16+) were highest among the children diagnosed with shaken infant syndrome.

In a comparison of children admitted for acute injuries only (Table 2), abused children as compared to the unexposed group suffered a disproportionate number of fractures to the torso (10.6% vs. 1.7%), internal injuries of the brain (33.2% vs. 22.6%), internal injuries of the torso (7.8% vs. 3.5%) and open wounds of the torso (2.0% vs. 0.9%). Of torso injuries, 65 cases suffered injuries to the urogenital organs, 13 were suspected of sexual abuse (11 of which were female) and 52 suspected of physical abuse (21 females). Among the comparison group, 21 children were diagnosed with injuries to the urogenital organs. Burns were less common among cases than controls (Table 2). When complications resulting from traumatic injuries were evaluated, the cases of maltreatment disproportionately suffered from the following: cerebral oedema/anoxia/encephalopathy (9.5% vs. 0.1%; $p < 0.001$), pulmonary insufficiency (2.5% vs. 0.3%; $p < 0.001$), and acute respiratory failure (4.8% vs. 0.5%; $p < 0.001$). Table 3 presents diagnostic patterns for disease by type of maltreatment.

Discharge status

Among the maltreated children, 75.6% were discharged home, 2.9% into child protective services and 15.8% to an intermediate care facility (e.g. rehabilitation centre). In contrast, 87.5% of comparison group were discharged home and 10.9% were discharged to an intermediate care facility. The remaining children in both groups were discharged to either an unspecified location or the morgue. Although the majority of exposed and unexposed cases were discharged home, no information was available within

Table 2
Description of injury type by body part affected among acute injury cases resulting in hospitalization in Illinois, 2000–2009.

Injury type	Maltreatment cases (n = 1787)*	Comparison group[a] (n = 1001)*	p-Value
Fracture			
Skull	294 (16.5%)	256 (25.6%)	<0.001
Other head/face	20 (1.1%)	18 (1.8%)	0.138
Vertebral column	20 (1.1%)	4 (0.4%)	0.049
Torso	190 (10.6%)	17 (1.7%)	<0.001
Upper extremity	232 (13.0%)	99 (9.9%)	0.015
Lower extremity	282 (15.8%)	100 (10.0%)	<0.001
Internal injuries			
Traumatic brain injury	593 (33.2%)	226 (22.6%)	<0.001
Spinal cord	3 (0.2%)	1 (0.1%)	–
Torso	139 (7.8%)	35 (3.5%)	<0.001
Open wounds			
Head/face	75 (4.2%)	67 (6.7%)	0.004
Torso	35 (2.0%)	9 (0.9%)	0.031
Upper extremity	16 (0.9%)	18 (1.8%)	0.037
Lower extremity	9 (0.5%)	13 (1.3%)	0.023
Burns			
Head/face	31 (1.7%)	49 (4.9%)	<0.001
Torso	77 (4.3%)	74 (7.4%)	<0.001
Upper extremity	58 (3.2%)	84 (8.4%)	<0.001
Lower extremity	85 (4.8%)	51 (5.1%)	0.691

* Only cases suffering acute traumatic injuries included in this table.
[a] Comparison group-random selection from a list of all patients under the age of 13 without indication of maltreatment. Matched with cases by age and dataset of origin (trauma registry and hospital discharge).

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Table 3
Description of most common diagnoses among suspected child maltreatment cases resulting in hospitalization in Illinois, 2000–2009.

Diagnosis*	Child Physical Abuse (N=1525)	Shaken Infant Syndrome (N=430)	Child Neglect (N=350)	Child Emotional & Psychological Abuse (N=12)	Child Sexual Abuse (N=166)	Child abuse, Unspecified (N=173)	Maltreatment Cases (n=2656)	Comparison Group[a] (n=2656)	P-value
Disorders Eye & Ear	266 (17.4%)	277 (64.4%)	32 (9.1%)	0 (0.0%)	7 (4.2%)	22 (12.7%)	604 (22.7%)	207 (7.8%)	<0.001
Retinal hemorrhage	151 (9.9%)	254 (59.1%)	2 (0.6%)	0 (0.0%)	0 (0.0%)	4 (2.3%)	411 (15.5%)	4 (0.2%)	<0.001
Conjunctival hemorrhage	40 (2.6%)	2 (0.5%)	1 (0.3%)	0 (0.0%)	0 (0.0%)	2 (1.2%)	45 (1.7%)	0 (0.0%)	<0.001
Coagulation Disorders	20 (1.3%)	16 (3.7%)	3 (0.9%)	0 (0.0%)	2 (1.2%)	5 (2.9%)	46 (1.7%)	19 (0.7%)	<0.001
Hereditary Degen Disorders of CNS	27 (1.8%)	30 (7.0%)	2 (0.6%)	0 (0.0%)	0 (0.0%)	2 (1.2%)	61 (2.3%)	22 (0.8%)	<0.001
Obstructive/Acquired hydrocephalus	14 (0.9%)	24 (5.6%)	2 (0.6%)	0 (0.0%)	0 (0.0%)	2 (1.2%)	42 (1.6%)	17 (0.6%)	0.001
Other CNS Disorders	157 (10.3%)	143 (33.3%)	23 (6.6%)	0 (0.0%)	0 (0.0%)	15 (8.7%)	338 (12.7%)	66 (2.5%)	<0.001
Infantile Cerebral Palsy	26 (1.7%)	6 (1.4%)	14 (4.0%)	0 (0.0%)	0 (0.0%)	8 (4.6%)	54 (2.0%)	28 (1.1%)	0.004
Epilepsy	20 (1.3%)	29 (6.7%)	6 (1.7%)	0 (0.0%)	0 (0.0%)	3 (1.7%)	58 (2.2%)	18 (0.7%)	<0.001
Anoxic brain damage	35 (2.3%)	46 (10.7%)	1 (0.3%)	0 (0.0%)	0 (0.0%)	1 (0.6%)	83 (3.1%)	2 (0.1%)	<0.001
Disorders of the Circulatory System	96 (6.3%)	93 (21.6%)	15 (4.3%)	1 (8.3%)	2 (1.2%)	24 (13.9%)	231 (8.7%)	100 (3.8%)	<0.001
Cardiac dysrythmias	32 (2.1%)	24 (5.6%)	6 (1.7%)	1 (8.3%)	2 (1.2%)	11 (6.4%)	76 (2.9%)	34 (1.3%)	<0.001
Intracranial hemorrhage	27 (1.8%)	28 (6.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	7 (4.0%)	62 (2.3%)	9 (0.3%)	<0.001
Occlusion of cerebral arteries	13 (0.9%)	23 (5.3%)	1 (0.3%)	0 (0.0%)	0 (0.0%)	1 (0.6%)	38 (1.4%)	2 (0.1%)	<0.001
Diabetes insipidus / Vasopressin Deficiency	13 (0.9%)	13 (3.0%)	1 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	27 (1.0%)	3 (0.1%)	<0.001
Symptoms	361 (23.7%)	290 (67.4%)	173 (49.4%)	1 (8.3%)	26 (15.7%)	59 (34.1%)	910 (34.3%)	486 (18.3%)	<0.001
Convulsions	162 (10.6%)	228 (53.0%)	28 (8.0%)	0 (0.0%)	4 (2.4%)	13 (7.5%)	435 (16.4%)	98 (3.7%)	<0.001
Feeding difficulties	67 (4.4%)	34 (7.9%)	115 (32.9%)	1 (8.3%)	5 (3.0%)	13 (7.5%)	235 (8.8%)	56 (2.1%)	<0.001
Infectious Diseases	97 (6.4%)	47 (10.9%)	67 (19.1%)	1 (8.3%)	17 (10.2%)	16 (9.2%)	245 (9.2%)	318 (12.0%)	0.001
Unspecified protein calorie malnutrition	21 (1.4%)	6 (1.4%)	23 (6.6%)	0 (0.0%)	0 (0.0%)	3 (1.7%)	53 (2.0%)	3 (0.1%)	<0.001
Injuries Caused by Nature & Environment	12 (0.8%)	3 (0.7%)	9 (2.6%)	1 (8.3%)	0 (0.0%)	0 (0.0%)	25 (0.9%)	13 (0.5%)	0.051
Diseases of the Skin	84 (5.5%)	18 (4.2%)	53 (15.1%)	0 (0.0%)	8 (4.8%)	15 (8.7%)	178 (6.7%)	112 (4.2%)	<0.001
Atopic dermatitis	25 (1.6%)	5 (1.2%)	22 (6.3%)	0 (0.0%)	1 (0.6%)	6 (3.5%)	59 (2.2%)	19 (0.7%)	<0.001
Congential Anomalies	55 (3.6%)	21 (4.9%)	33 (9.4%)	0 (0.0%)	1 (0.6%)	21 (12.1%)	131 (4.9%)	196 (7.4%)	<0.001
Anemias	125 (8.2%)	77 (17.9%)	41 (11.7%)	0 (0.0%)	6 (3.6%)	12 (6.9%)	261 (9.8%)	86 (3.2%)	<0.001
Iron Deficiency Anemia	24 (1.6%)	12 (2.8%)	17 (4.9%)	0 (0.0%)	2 (1.2%)	5 (2.9%)	60 (2.3%)	14 (0.5%)	<0.001
Unspecified Anemia	97 (6.4%)	63 (14.7%)	16 (4.6%)	0 (0.0%)	2 (1.2%)	4 (2.3%)	182 (6.9%)	45 (1.7%)	<0.001
Mental Disorders	83 (5.4%)	25 (5.8%)	49 (14.0%)	8 (66.7%)	69 (41.6%)	22 (12.7%)	256 (9.6%)	95 (3.6%)	<0.001
Bipolar / Mania	18 (1.2%)	0 (0.0%)	3 (0.9%)	3 (25.0%)	40 (24.1%)	8 (4.6%)	72 (2.7%)	31 (1.2%)	<0.001
Adjustment Reaction / Prolonged PTSD	12 (0.8%)	1 (0.2%)	12 (3.4%)	3 (25.0%)	32 (19.3%)	3 (1.7%)	63 (2.4%)	8 (0.3%)	<0.001
Impulse Control Issues	2 (0.1%)	1 (0.2%)	6 (1.7%)	2 (16.7%)	19 (11.4%)	1 (0.6%)	31 (1.2%)	15 (0.6%)	0.018
Developmental Delays	27 (1.8%)	10 (2.3%)	21 (6.0%)	1 (8.3%)	4 (2.4%)	3 (1.7%)	66 (2.5%)	18 (0.7%)	<0.001
Perinatal Conditions	18 (1.2%)	8 (1.9%)	33 (9.4%)	0 (0.0%)	2 (1.2%)	8 (4.6%)	69 (2.6%)	133 (5.0%)	<0.001
Disorders of Muscle & Connective Tissue	51 (3.3%)	3 (0.7%)	13 (3.7%)	1 (8.3%)	4 (2.4%)	15 (8.7%)	87 (3.3%)	46 (1.7%)	<0.001
Malignant Neoplasms	1 (0.1%)	1 (0.2%)	2 (0.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4 (0.2%)	62 (2.3%)	<0.001
White Blood Cell Disorders	3 (0.2%)	1 (0.2%)	0 (0.0%)	0 (0.0%)	1 (0.6%)	1 (0.6%)	6 (0.2%)	36 (1.4%)	<0.001
Other Blood Disorders	4 (0.3%)	3 (0.7%)	1 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	8 (0.3%)	14 (0.5%)	0.200
Disorders of the Respiratory System	237 (15.5%)	118 (27.4%)	81 (23.1%)	1 (8.3%)	23 (13.9%)	41 (23.7%)	501 (18.9%)	760 (28.6%)	<0.001
Digestive System Disorders	90 (5.9%)	49 (11.4%)	51 (14.6%)	1 (8.3%)	13 (7.8%)	18 (10.4%)	222 (8.4%)	255 (9.6%)	0.113
Liver Disease	21 (1.4%)	3 (0.7%)	11 (3.1%)	0 (0.0%)	2 (1.2%)	3 (1.7%)	40 (1.5%)	30 (1.1%)	0.229
Kidney Disorders	11 (0.7%)	6 (1.4%)	5 (1.4%)	0 (0.0%)	2 (1.2%)	1 (0.6%)	25 (0.9%)	38 (1.4%)	0.099
Other UrniaryTract Disorders	29 (1.9%)	25 (5.8%)	9 (2.6%)	0 (0.0%)	9 (5.4%)	4 (2.3%)	76 (2.9%)	68 (2.6%)	0.499
Genital Organs	9 (0.6%)	1 (0.2%)	2 (0.6%)	0 (0.0%)	0 (0.0%)	1 (0.6%)	13 (0.5%)	14 (0.5%)	0.847
Female Organs	1 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	16 (9.6%)	2 (1.2%)	19 (0.7%)	6 (0.2%)	0.009
Abnormal Finidngs	58 (3.8%)	24 (5.6%)	16 (4.6%)	0 (0.0%)	13 (7.8%)	13 (7.5%)	124 (4.7%)	96 (3.6%)	0.054

The boxes are intended to highlight the constellations of common diagnoses observed in the different abuse groups, one of the key outcomes of the study.
* ICD-9-CM codes for specific diagnoses: 280 iron deficiency, 285 unspecified anaemia, 286 coagulation defects, 296 bipolar/mania, 309 adjustment rx, 312.3 impulse control, 314 hyperkinesis, 313 emotional disturbances, 315 developmental delays, 331.4 obstructive hydrocephalus, acquired hydrocephalus, 343 infantile cerebral palsy, 345 epilepsy, 348.1 anoxic brain damage, 362.81 retinal haemorrhage, 372.72 conjunctival haemorrhage, 382 otitis media, 427 cardiac dysrythmias, 430–432 intracranial haemorrhage, 434 occlusion of cerebral arteries, 682 cellulitis/abcess, 691 atopic dermatitis, 692.9 contact dermatitis unspec, 780.3 convulsions, 783.4 feeding difficulties, 263.9 unspecified protein-calorie malnutrition, 253.5 diabetes insipidus, vasopressin deficiency.
[a] Comparison group-random selection from a list of all patients under the age of 13 without indication of maltreatment; matched with cases by age and dataset of origin (trauma registry and hospital discharge).

the datasets on whether the children were returning to the same home as the perpetrator or to another gaurdian's home (e.g. the other parent (divorce), a grandparent, etc.). Among the cases of maltreatment, children discharged into child custody were disproportionately hospitalized for acute injury (97.4% vs. 66.4%; $p < 0.001$), had a father, stepfather, boyfriend, or male partner of the child's parent or guardian identified as the perpetrator (44.9% vs. 17.4%; $p < 0.001$), or suffered physical abuse as compared to other types of maltreatment (93.6% vs. 56.3%; $p < 0.001$). Maltreated children discharged into child protective custody did not significantly differ from other abused children in terms of age, gender, or length of hospitalization.

In-hospital deaths

There were a total of 133 in-hospital fatalities in this study, of which 111 (4.2%) were among the cases of maltreatment and 22 (0.8%) occurred among the comparison group. The highest case-fatality rates were observed among the children suffering physical abuse ($N = 51$, 3.8%) and Shaken Infant Syndrome ($N = 43$; 10.0%).

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Among maltreated children who died, 82.9% ($N = 92$) suffered a type 1 traumatic brain injury, the most serious type of head injuries.[10] Interestingly, the case fatality rate of abused children suffering type 1 traumatic brain injuries was substantially higher than the comparison group suffering the same type of injuries ($N = 92$, 9.8% vs. $N = 4$, 1.7%; $p < 0.001$). In the final multivariable logistic regression model, maltreated children continued to have a higher odds of dying during hospitalization (adjusted OR = 2.99; CI95%: 1.63, 5.45).

Discussion

Our study presents detailed information on diagnostic patterns and outcomes among suspected cases of child maltreatment admitted to Illinois hospitals over a 10-year period. The findings show distinct diagnostic patterns for each of the suspected maltreatment categories. Most of these diagnoses have been well described in the literature, in particular indicators of abuse among children presenting with acute injuries.[16–18] However, our study also provides diagnostic patterns for children suffering emotional abuse, sexual abuse and neglect. Some of the diagnoses disproportionately occurred in children suspected of being abused or neglected, and the comparison group were rarely or never diagnosed with these disorders, such as subconjunctival haemorrhage, malnutrition, anaemia with an unknown cause, and certain psychiatric diagnoses (Table 3).

Maltreated children had substantially higher odds of dying during the hospitalization than their age matched non-abused counterparts, which corresponded to the finding that other measures of severity such as length of hospitalization significantly exceeded that of the comparison group. The primary cause of death among the maltreated children resulted from serious traumatic brain injuries and corresponds to the large proportion of Shaken Infant Syndrome cases included in this study.

Although the majority of cases of maltreatment were discharged home, no information was available within the datasets on whether the child was returning to the same home as the perpetrator or to another gaurdian's home (e.g. the other parent living in a separate home, a grandparent, etc.). The safety of the children should not be measured by how many go into foster care, but whether there is adequate discharge planning by the medical staff and child protective services personnel, in order to reduce the risk of repeated abuse and neglect. It was interesting that those suffering physical abuse as compared to other types of abuse were more likely to be discharged into child protective custody.

Past studies have restricted their analyses to children suffering specific types of injuries such as orthopaedic injuries, head injuries, or occult abdominal injuries. However, our dataset provides a comprehensive overview of a large group of children across the State of Illinois suffering from multiple forms of abuse and neglect. Regardless of the focus of past studies, the data clearly shows that infants and toddlers are the most likely to be identified of suspected severe abuse and neglect.[19–22] Boys were more likely than girls to be maltreated within the exposed group, but the proportion of injuries suffered by boys was comparable between cases of maltreatment and the comparison group. National data indicates that boys have a higher rate of maltreatment than girls prior to the age of three years.[19] At ages 4–7 years, boys and girls appear to suffer equivalent rates of maltreatment, but after 8 years of age the incidence of child abuse and neglect is higher in girls.[19] However, in our study the distribution of abused boys and girls did not differ by age. This higher rate of abuse in girls as reported in national studies is explained by an increase in sexual abuse; most cases of sexual assault will not be treated in a trauma unit unless severe physical injuries occur.[23]

Limitations

It very likely that there were children in the registry that were not identified as abused or neglected. Recent studies indicate that medical personnel fail to identify as much as 64% of the cases of abuse and neglect presenting in emergency rooms.[24–26] In particular, cases that present with non-specific signs/symptoms (e.g. vomiting, fussiness, poor feeding, lethargy) and no external signs of abuse or trauma.[27] Most of the cases of maltreatment in this analysis were infants and toddlers who are incapable of informing medical personnel about the cause of their injuries. Older children who are maltreated may be afraid or reluctant to inform the medical staff about maltreatment, especially if it involves a parent. Some children may simply be unable to differentiate between what is acceptable behaviour and abusive behaviour. However, the majority of hospitals have protocols for managing child maltreatment, and medical staff are well educated about child maltreatment, and the legal statutes are well defined for acting to protect maltreated children.[28] Combined, this contributes to a heightened awareness of the issue of child maltreatment and promotes active screening for abuse. Research has shown that reporting of child abuse increases with an increase in severity.[5] This study only includes cases severe enough to require hospitalization, but it is unknown how many hospitalized children were not identified and hereby missed for inclusion to this study.

Although the patients were matched on age and data source, almost none of the comparison group randomly identified through the hospital discharge dataset suffered injuries, whereas many of maltreatment cases identified in this dataset did suffer acute injuries. This occurred because we were in part selectively identifying physical abuse incidents in the maltreatment group, but randomly sampled from the general child inpatient population for the comparison group which comprises predominately of children admitted for illnesses. Furthermore, children admitted for acute injuries were substantially more likely to die during hospitalization regardless of maltreatment status. To control for confounding that may have occurred because of the selection procedure, we controlled for diagnosis of an acute injury (yes/no), severe injuries (NISS ≥ 16) and complications associated with increased mortality in trauma patients. Despite controlling for these important covariates related to injury, the abused cases continued to have a higher risk of in-hospital mortality than the controls. In addition, when we looked at the case fatality rate among those admitted for illnesses only, the maltreated children had were still more than twice as likely to die as controls (1.73% cases vs. 0.66% controls).

In longitudinal studies, even short periods of follow-up such as a single hospitalization stay, time dependent variables are often both potential confounders and outcomes along the causal pathway. In this analysis, some of the covariates are treated as proxy measures of injury severity (length of stay, requiring mechanical ventilation, and medical complications following trauma). However, because they are potential outcomes in their own right, there is concern that they may bias the model estimates of the relationship between abuse and in-hospital mortality. Generally, over-specified models that include covariates along the causal pathway result in a conservative bias of the parameter estimates of interest. Omission of these covariates from the main model in this study (length of stay, requiring surgical intervention, requiring mechanical ventilation, and medical complications following trauma) had a minor effect on the relationship between abuse and in-hospital mortality (adjusted OR = 2.70; CI95%: 1.57, 4.67).

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Physicians and nurses are trained in conducting medical histories to document pre-existing conditions and medication/drug use, identify signs and symptoms, and note any conditions or issues that may impact treatment. Intake interviews and screens are conducted on all admitted patients uniformly. It is unlikely that intake screening would differ between cases and controls since in most instances, the cases were not identified as abused until after the admission process or several days into the hospitalization.

Conclusions

The findings show distinct constellations of shared comorbidities, diagnoses and outcomes within and between different groups of maltreated children admitted to hospitals confirming observations in many smaller studies and larger national cross-sectional surveys.[16,17,19,29] The abused and neglected children suffered more severe outcomes than the unexposed group and were more likely to die during hospitalization.

Conflict of interest statement

All authors declare that have no conflicts of interest.

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References

1. Runyon D, Wattam C, Ikeda R, Hassan F, Ramiro L. Child abuse and neglect by parents and other caregivers. In: Krug EG, Dahlberg LL, Mercy JA, Zwi AB, Lozano R, editors. *World report on violence and health*. Geneva: World Health Organization; 2002. p. 57–80.
2. Lynch MA. Child abuse before Kempe: an historical literature review. *Child Abuse and Neglect* 1985;**9**:7–15.
3. Thomas DE, Leventhal JM, Friedlaender E. Referrals to a hospital based child abuse committee: a comparison of the 1960s and 1990s. *Child Abuse and Neglect* 2001;**25**:203–13.
4. Friedlaender EY, Rubin DM, Alpern ER, Mandell DS, Christian CW, Alessandrini EA. Patterns of health care use that may identify young children who are at risk for child maltreatment. *Pediatrics* 2005;**116**(6):1303–8.
5. Annerback E-M, Lindell C, Svedin CG, Gustafsson PA. Severe child abuse: a study of cases reported to the police. *Acta Paediatrica* 2007;**96**:1760–4.
6. Gessner BD, Moore M, Hamilton B, Muth PT. The incidence of infant physical abuse in Alaska. *Child Abuse and Neglect* 2004;**28**:9–23.
7. Hurme T, Alanko S, Anttila Pl. Juven T, Svedstrom E. Risk factors for physical child abuse in infants and toddlers. *European Journal of Pediatric Surgery* 2008;**18**:387–91.
8. Mok JY. Non-accidental injury in children – an update. *Injury* 2008;**39**:978–85.
9. Friedman LS, Forst L. Occupational injury surveillance of traumatic injuries in Illinois, using the Illinois trauma registry: 1995–2003. *Journal of Occupational and Environmental Medicine* 2007;**49**(4):401–10.
10. Barell V, Aharonson-Daniel L, Fingerhut LA. An introduction to the Barell body region by nature of injury diagnosis matrix. *Injury Prevention* 2002;**8**:91–6.
11. Baker SP, O'Neill B, Haddon W, Long WB. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. *Journal of Trauma* 1974;**14**:187–96.
12. Osler T, Baker SP, Long W. A modification of the injury severity score that both improves accuracy and simplifies scoring. *Journal of Trauma* 1997;**43**(December (6)):922–5.
13. Stevenson M, Segui-Gomez M, Lescohier I, Di Scala C, McDonald-Smith G. An overview of the injury severity score and the new injury severity score. *Injury Prevention* 2001;**7**(1):10–3.
14. Copes WS, Champion HR, Sacco WJ, Lawnick MM, Keast SL, Bain LW. The injury severity score revisited. *Journal of Trauma* 1988;**28**(1):69–77.
15. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *Journal of Chronic Diseases* 1987;**40**(5):373–83.
16. Reece RM, Christian CW. *Child abuse: medical diagnosis and management*. Elk Grove Village, IL: American Academy of Pediatrics; 2009.
17. Chang DC, Knight V, Ziegfeld S, Haider A, Warfield D, Paidas C. The tip of the iceberg for child abuse: the critical roles of the pediatric trauma service and its registry. *Journal of Trauma* 2004;**57**(December (6)):1189–98.
18. Pandya NK, Baldwin K, Wolfgruber H, Christian CW, Drummond DS, Hosalkar HS. Child abuse and orthopaedic injury patterns: analysis at a level 1 pediatric trauma center. *Journal of Pediatric Orthopedics* 2009;**29**(6):618–25.
19. US Department of Health and Human Services, Administration for Children and Families, Administration on Children, Youth and Families, Children's Bureau. 2010. Child Maltreatment 2008. Available from: http://www.acf.hhs.gov/programs/cb/stats_research/index.htm#can [last accessed November, 2011].
20. Lane WG, Dubowitz H, Langenberg P. Screening for occult abdominal trauma in children with suspected physical abuse. *Pediatrics* 2009;**124**:1595–602.
21. Leventhal JM, Martin KD, Asnes AG. Incidence of fractures attributable to abuse in young hospitalized children: results from analysis of a United States database. *Pediatrics* 2008;**122**:599–604.
22. Tingberg B, Falk A, Flodmark O, Ygge B. Evaluation of documentation in potential abusive head injury of infants in a paediatric emergency department. *Acta Paediatrica* 2009;**98**:777–81.
23. Sedlak AJ, Broadhurst DD. Executive summary of the third national incidence study of child abuse and neglect [Internet]. US Dept of Health and Human Services; 1996. Available from: http://www.childwelfare.gov/pubs/statsinfo/nis3.cfm#child [cited 30.11.10].
24. Woodman J, Pitt M, Wentz R, Taylor B, Hodes D, Gilbert RE. Performance of screening tests for child physical abuse in accident and emergency departments. *Health Technology Assessment* 2008;**12**(November (33)). iii, xi–xiii, 1–95.
25. Louwers EC, Affourtit MJ, Moll HA, de Koning HJ, Korfage IJ. Screening for child abuse at emergency departments: a systematic review. *Archives of Disease in Childhood* 2010;**95**(March (3)):214–8.
26. Gilbert R, Kemp A, Thoburn J, Sidebotham P, Radford L, Glaser D, *et al.* Recognising and responding to child maltreatment. *Lancet* 2009;**373**:167–80.
27. Hettler J, Greenes DS. Can the initial history predict whether a child with a head injury has been abused? *Pediatrics* 2003;**111**(March (3)):602–7.
28. McNamara RM, Rousseau E, Sanders AB. Geriatric emergency medicine: a survey of practicing emergency physicians. *Annals of Emergency Medicine* 1992;**21**(7):796–801.
29. DiScala C, Sege R, Li G, Reece RM. Child abuse and unintentional injuries: a 10-year retrospective. *Archives of Pediatrics and Adolescent Medicine* 2000;**154**(January (1)):16–22.

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