

# Epidemiology and clinical analysis of critical patients with child maltreatment admitted to the intensive care units

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## Abstract

Children with abuse who are admitted to the intensive care unit (ICU) may have high mortality and morbidity and commonly require critical care immediately. It is important to understand the epidemiology and clinical characteristics of these critical cases of child maltreatment.

We retrospectively evaluated the data for 355 children with maltreatments admitted to the ICU between 2001 and 2015. Clinical factors were analyzed and compared between the abuse and the neglect groups, including age, gender, season of admission, identifying settings, injury severity score (ISS), etiologies, length of stay (LOS) in the ICU, clinical outcomes, and mortality. In addition, neurologic assessments were conducted with the Pediatric Cerebral Performance Category (PCPC) scale.

The most common type of child maltreatments was neglect (n=259), followed by physical abuse (n=96). The mean age of the abuse group was less than that of the neglect group ( $P < .05$ ). Infants accounted for the majority of the abuse group, and the most common etiology of abuse was injury of the central nervous system (CNS). In the neglect group, most were of the preschool age and the most common etiologies of abuse were injury of the CNS and musculoskeletal system ( $P < .001$ ). The mortality rate in the ICU was 9.86%. The ISS was significantly associated with mortality in both the 2 groups (both  $P < .05$ ), whereas the LOS in the ICU and injuries of the CNS, musculoskeletal system, and respiratory system were all associated with mortality in the neglect group (all  $P < .05$ ). The PCPC scale showed poor prognosis in the abuse group as compared to the neglect group ( $P < .01$ ).

In the ICU, children in the abuse group had younger age, higher ISS, and worse neurologic outcome than those in the neglect group. The ISS was a predictor for mortality in the abuse and neglect groups but the LOS in the ICUs, injuries of the CNS, musculoskeletal system, and respiratory system were indicators for mortality in the neglect group. Most importantly, identifying the epidemiological information may provide further strategies to reduce the harm, lower the medical costs, and improve clinical care quality and outcomes in children with abuse.

**Abbreviations:** AHI = abusive head injury, CI = confidence interval, CNS = central nervous system, ED = emergency department, ICU = intensive care unit, ISS = injury severity score, LOS = length of stay, PCPC = Pediatric Cerebral Performance Category, SD = standard deviation.

**Keywords:** child abuse, etiology, intensive care units, neglect, physical abuse

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## 1. Introduction

Child maltreatment is one of the most concerning issues in the world that affects children younger than 18 years of age. Broadly defined, child maltreatment can be distinguished into 5 subtypes: physical abuse, sexual abuse, emotional abuse, and neglect. The morbidity and mortality caused by child maltreatment is a serious problem in the world<sup>[1–5]</sup> and can have long-term consequences. Physical abuse and neglect account for most cases of child maltreatment and are significant causes of child death.<sup>[2]</sup> Physical abuse is defined as those acts of commission by a caregiver that cause actual physical harm or have the potential for harm.<sup>[3–5]</sup> Neglect is defined as a failure by a child's caregiver to meet the physical, emotional, educational, or medical needs of the child.<sup>[6]</sup> According to the World Health Organization, physical abuse reports are associated with more severe injuries and higher mortality than neglect.<sup>[3]</sup> Clinically, understanding the epidemiologic data of children with maltreatment can promote accurate clinical evaluation and decision-making.

Critically ill patients with child maltreatment are admitted to the intensive care unit (ICU) for critical care, and the etiology of their injuries may be initially categorized into physical abuse and neglect. Children admitted to the ICU may possibly suffer from unstable vital signs and require emergency and critical care. Analyzing the epidemiology and prognosis in children who are critically ill due to maltreatment may be helpful for clinicians in the evaluation of related clinical conditions and outcomes in the ICU. In addition, epidemiologic patterns can help identify the most prevalent etiologies in critically ill children, and the data can provide meaningful information to prevention programs. Therefore, this study investigated the epidemiologic patterns of child maltreatment in critically ill pediatric patients who were admitted to the ICU and analyzed the severity of injuries and clinical outcomes to identify the best practices for improving clinical outcomes in these children.

## 2. Materials and methods

### 2.1. Patient population

This retrospective study was conducted from January 2001 to December 2015. The study included patients aged <18 years who were reported of abuse or neglect by the social welfare reporting system and, who had visited an emergency department (ED), been transferred from another hospital, or been routinely admitted at the Chang Gung Memorial Hospital at Linko, a 3300-bed medical central in Taiwan. The condition of the children with maltreatment who were admitted to the ICU was classified as either physical abuse or neglect. ICU admission of patients followed the guidelines of the Society of Critical Care Medicine,<sup>[4]</sup> meeting at least one of its defined criteria. The study was approved by the Institutional Review Board of the Chang Gung Memorial Hospital.

### 2.2. Methods

The information analyzed included the following: patient age, sex, season of admission, identifying settings, injury severity score (ISS), etiology of trauma, length of stay (LOS) in the ICU, neurologic outcomes, and mortality. The ICU admissions were categorized by type of ICU: pediatric, neurosurgery, or surgical. All cases were categorized into the 4 age groups: infants (<1 year), preschool age (1 to <6 years), school age (6 to <12 years), and adolescents (12 to <18 years). The following 7 categories

comprised the etiologies of the ICU admissions: (1) injury of the central nervous system (CNS), (2) injury of the musculoskeletal system, (3) injury of the respiratory system, (4) poisoning, (5) injury of the circulatory system, (6) injury of the digestive system, and (7) symptoms, signs, and ill-defined conditions. Correlations between the different age groups and the etiologies were analyzed. Moreover, we also analyzed related factors such as sex, age, LOS in the ICUs, season of admission, and etiologies, and the correlation of mortality in pediatric critically ill patients in the ICU. Second, morbidity was assessed by checking general functional status and discharge from the ICU was determined using the Pediatric Cerebral Performance Category (PCPC) scale. Good prognosis was defined as scores 1 and 2 on the PCPC scale, whereas poor prognosis was defined as scores 3 to 6.

### 2.3. Statistical analysis

Descriptive data were presented as mean  $\pm$  standard deviation (SD). We analyzed the data by using the Fisher exact test, chi-square test, or student t-test, where appropriate. The difference between groups was presented as the 95% confidence interval (CI). The distribution of variables was reported as percentages and mean  $\pm$  SD. Statistical significance was defined at the  $P < .05$  level. Statistical analyses were performed with SPSS software (version 22.0, IBM Corp., Armonk, NY).

## 3. Results

### 3.1. Study population

During the 15-year study period, 1838 children aged <18 years, with abuse and neglect reporting from the social welfare reporting system, were included. The in-hospital admission rate to the ICU of the forensic cases was 19.3%, which accounted for 355 patients. The most common type of child maltreatment was neglect ( $n=259$ , 73%), followed by physical abuse ( $n=96$ , 27%). From 2001 to 2011, the distribution of patients admitted to the ICU due to physical abuse and neglect was nearly steady, but it markedly increased during the period from 2012 to 2015 (Fig. 1).

### 3.2. Characteristics of pediatric critically ill patients in the ICU

Of the 355 critically ill children transferred to the ICU from the ED, 232 were male (65.4%) and 123 female (34.6%) patients, with a mean age of  $3.4 \pm 3.8$  years (Table 1). The mean age was lower in the abuse group ( $0.77 \pm 0.98$  years) than that in the neglect group ( $4.32 \pm 4.04$  years) ( $P < .01$ ). In the abuse group, most were infants ( $n=76$ , 79.1%), and in the neglect group, most were preschool children ( $n=153$ , 59.1%) ( $P < .01$ ). Summer was the most common season for children with abuse to be admitted to the ICU. The most common setting to be transferred from, in both the abuse and neglect groups, was another hospital, followed by the ED. Children with physical abuse had higher ISS and longer LOS in the ICU than those with neglect (both  $P < .01$ ). Emergency surgeries were performed in approximately half of the cohort: 54 (56.3%) cases in the abuse group and 130 (50.2%) cases in the neglect group. The evaluation of the neurological outcome using the PCPC scale indicated a poor prognosis 4 times more often than a good prognosis in the abuse group, whereas a good prognosis was indicated 4 times more often than a poor prognosis in the neglect group ( $P < .01$ ).



Figure 1. Numbers of various child maltreatment cases in ICUs: 2001–2015.

### 3.3. Analysis of etiologies based on different age groups

Of the children with maltreatment 127 (35.7%) in the infant group, 173 (48.7%) in the preschool age group, 39 (10.9%) in the school age group, and 16 (4.7%) in adolescents (Table 2). The male sex was predominant in all 4 age groups (Fig. 2). Of the 7 etiologic categories determined, the most common etiology was injury of the CNS (n=204, 57.5%), followed by injury of the muscular system (n=81, 22.8%). Moreover, infants (n=68, 70.1%) accounted for the majority in the abuse group, and injury of the CNS was the most common etiology. The preschool age group accounted for the majority in the neglect group, and the most common etiologies were injuries of the CNS (n=62, 23.9%) and musculoskeletal system (n=60, 23.4%) (P<.001). In

addition, injury of the CNS was the major etiology in almost every month, followed by injury of the musculoskeletal system, but injury of the respiratory system was more commonly noted in the summer (Fig. 3).

### 3.4. Evaluation of clinical outcomes and prognosis in the ICU

In the ICU, the mortality rate of child maltreatment was 9.86% (n=35; 12.5% in the abuse group and 8.9% in the neglect group), with a mean age of 0.77±0.98 years in the abuse group and 4.32±4.04 years in the neglect group (P<.01) (Table 3). The most common age group for mortality was the infant age group (n=9, 75%) in the abuse group, whereas the most common age group in the neglect group was the preschool age group (n=10, 43.5%). On the basis of our mortality analysis, the ISS was significantly associated with mortality in both the abuse and neglect groups (P<.05), but the LOS in the ICU was associated with mortality in the neglect group (P<.05). However, both mortality and survival cases in the abuse group had longer LOS than the neglect group (P<.05). Among all etiologies in the abuse group, injury of the CNS accounted for most mortality (Table 4). However, in the neglect group, injury of the respiratory system was the most common etiology of mortality (n=17, 73.9%), followed by the CNS (n=4, 17.5%). In addition, among all etiologies in the neglect group, injury of the CNS, musculoskeletal system, and respiratory system were significantly associated with mortality in patients admitted to the ICU.

**Table 1**  
Demographics of forensic cases admitted to the ICU.

Demographics	Abusive trauma (n=96)	Neglectful trauma (n=259)	P
Age, y	0.77±0.98	4.32±4.04	<.01*
<1 y	76 (79.1)	51 (19.7)	<.01*
1 to <6 y	20 (20.9)	153 (59.1)	
6 to <12 y	0	39 (15.1)	
12 to <18 y	0	16 (6.1)	
Gender			.75
Male	61 (63.5)	171 (66)	
Female	35 (36.5)	88 (34)	
Seasons			.179
Spring	17 (17.7)	71 (27.4)	
Summer	34 (35.4)	83 (32.0)	
Fall	27 (28.1)	53 (20.5)	
Winter	18 (18.8)	52 (20.1)	
Identifying settings			.118
Emergent department	39 (40.6)	135 (52.1)	
Outpatient department	0 (0.0)	2 (0.8)	
Transfer	57 (59.4)	122 (47.1)	
Injury severity score	27.6±19.3	17.6±20.5	<.01*
Operation	54 (56.3)	130 (50.2)	.31
Outcomes			
ICU LOS, days	18.2±23.9	7.2±6.9	<.01*
Mortality	12 (12.5)	23 (8.9)	.415
PCPC			
Good prognosis	21 (21.8)	207 (79.9)	<.01*
Bad prognosis	75 (78.2)	52 (20.1)	<.01*

ICU=intensive care unit, LOS=length of stay, PCPC=pediatric cerebral performance category.

(%) means percentage.

\* Values was statistically significant (P<.05).

## 4. Discussion

Currently, child maltreatment is a serious issue in pediatric medicine, especially in the ICU. It also remains challenging for medical staff due to its high morbidity and mortality. This is the first study to analyze the epidemiology of children with physical abuse and neglect admitted to the ICU. In this 15-year retrospective analysis, we showed that the prevalence of in-hospital pediatric forensic cases admitted to the ICU was 19.3%. This finding indicates that when forensic cases are reported in the hospital, one-fifth of pediatric patients with maltreatment could be critically ill and may progress to mortality or permanent morbidity. This study showed that the mortality for child maltreatment in the ICUs was 9.86%, which was higher than the mortality rate of 2% to 6%, according to the pediatric ICU reports of the Society of Critical Care Medicine. The higher rate of mortality indicates that pediatric patients with maltreatment

**Table 2**  
**Analysis of etiologies in pediatric critically ill patients admitted to the ICU by different age groups.**

	<1 years	1 to <6 years	6 to <12 years	12 to <18 years	P
Gender					.77
Male	80 (63)	114 (65.9)	28 (71.8)	10 (62.5)	
Female	47 (37)	59 (34.1)	11 (28.2)	6 (37.5)	
Types of child abuse					<.01*
Physical abuse	76 (59.8)	20 (11.6)	0 (0)	0 (0)	
Neglect	51 (40.2)	153 (88.4)	39 (100)	16 (100)	
Severe ISS (25–75)	62 (48.8)	26 (15)	9 (23.1)	3 (18.8)	<.01*
Outcomes					.44
Mortality	14 (11)	13 (7.5)	6 (15.4)	2 (12.2)	
PCPC					<.01*
Bad prognosis (≥3)	72 (56.7)	39 (22.5)	11 (28.2)	5 (31.3)	
Etiologies					
Injury of the central nervous system	106 (83.5)	78 (45.1)	15 (38.5)	5 (31.3)	<.01*
Injury of the musculoskeletal system	7 (5.5)	61 (35.3)	10 (25.6)	3 (18.8)	<.01*
Injury of the respiratory system	7 (5.5)	12 (6.9)	10 (25.6)	1 (6.3)	<.01*
Poisoning	2 (1.6)	14 (8.1)	2 (5.1)	4 (25)	<.01*
Injury of the circulatory system	1 (0.8)	1 (0.6)	0 (0)	0 (0)	.934
Injury of the digestive system	0 (0)	7 (4)	2 (5.1)	3 (18.8)	<.01*
Symptoms, signs, and ill-defined conditions	4 (3.1)	0 (0)	0 (0)	0 (0)	.06

ICU = intensive care unit, ISS = injury severity score, PCPC = pediatric cerebral performance category.

( ): %.

\*P < .05 was statistically significant.

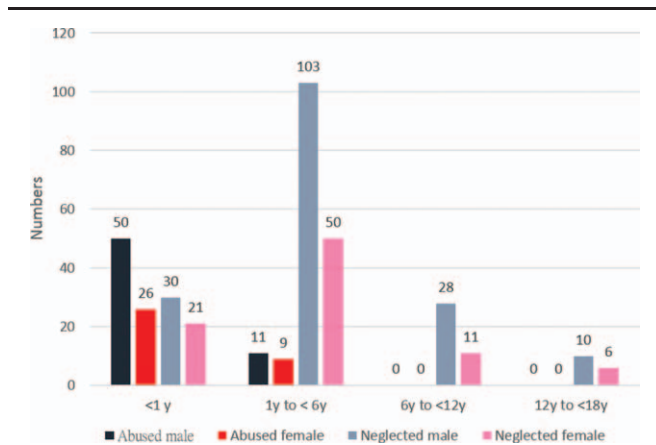


Figure 2. Analysis of etiologies according to months.

had higher severity and poorer prognosis than other critical pediatric diseases requiring critical care in the ICU. This finding also highlights the importance of child protection and prevention of child maltreatment now and in the future.

In this study, our results showed statistically significant differences in age, injury severity score, LOS in the ICU, and neurologic outcomes between the abuse and neglect groups. Of the ICU-admitted cases, the patients with physical abuse were younger than those with neglect. Younger children can be more easily irritated, are hard to appease, and are relatively unable to defend themselves, fight back, or report their injury.<sup>[7–9]</sup> This may explain the lower mean age in the abuse group than that in the neglect group. In addition, there were more boys than girls in this study, which is similar to previous studies.<sup>[7,10]</sup> Boys are more active and considered to need more physical discipline, or the punishment is thought to be a preparation for adult roles and responsibilities. According to the findings of the etiologic analysis based on the different age groups, injury of the CNS was the

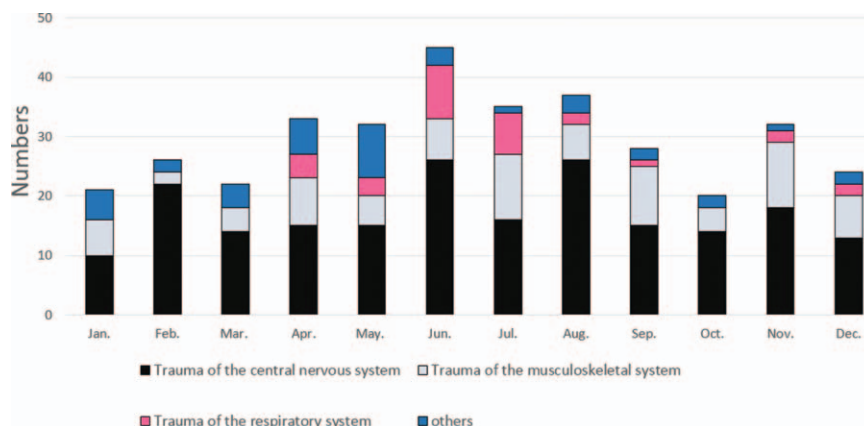


Figure 3. Numbers of child maltreatment cases according to age groups and gender.

**Table 3**  
**Analysis of etiologies by different age groups in both groups.**

Abusive trauma	<1 year	1 to <6 years	6 to <12 years	12 to <18 value	P years
<b>Abusive trauma</b>					
<b>Categories of diagnosis</b>					
Abused group					
Injury of the central nervous system	67	16	0	0	.446
Injury of the musculoskeletal system	3	1	0	0	.671
Injury of the respiratory system	1	0	0	0	.47
Poisoning	2	1	0	0	.88
Injury of the circulatory system	1	1	0	0	.88
Injury of the digestive system	0	1	0	0	.47
Symptoms, signs and ill-defined conditions	2	0	0	0	.887
Neglectful group					
Injury of the central nervous system	38	62	15	5	<.001*
Injury of the musculoskeletal system	4	60	10	3	<.001*
Injury of the respiratory system	6	12	10	1	.016*
Poisoning	1	13	2	4	.02*
Injury of the circulatory system	0	0	0	0	—
Injury of the digestive system	0	6	2	3	.014*
Symptoms, signs, and ill-defined conditions	2	0	0	0	.07

\*P<.05 was statistically significant.

major type of injury in children with maltreatment who were admitted to the ICU. This result is similar to findings from a pediatric trauma center,<sup>[11]</sup> but differs from other studies that showed the respiratory system as the major cause of injury in the ICU.<sup>[12,13]</sup> Injury of the CNS was more frequently seen in infants with physical abuse, indicating abusive head injury (AHI) could be the leading cause in the infant age. In addition, AHI may cause greater mortality and poor neurologic outcomes in infants, which is similar to the findings of other studies.<sup>[14,15]</sup> In contrast, in the neglect group, the main causes of CNS injury among preschool-age patients were traffic accidents, falls, and being struck by objects. This finding of different types of abuse depending on the age group reiterates the need for medical staff to identify a definitive and age-specific history of injury and suspect child abuse in the presence of intracranial injury of younger

patients.<sup>[8,16–18]</sup> Moreover, in the neglect group, injury of the musculoskeletal system and respiratory system were the second and third most common causes of trauma, respectively. Bone fracture in the preschool age group was the major cause of musculoskeletal injury, which may indicate its importance in noting the presence of a dangerous environment or harmful activity involving the child and the family. Injury of the respiratory system, mainly caused by drowning, occurred most often among children younger than 6 years of age. Therefore, health education for the parents to prevent environmental dangers and events could reduce the prevalence of critically ill patients who suffer from neglect.

The findings of the epidemiologic analysis showed that patients with physical abuse and neglect had different frequencies of etiologies at ICU admission, according to age group. The

**Table 4**  
**Correlation between mortality and age groups, gender, and etiologies in pediatric critically ill patients admitted to the ICU.**

Characteristics	Abused group		P value	Neglected group		P
	Mortality (n=12)	Survival (n=84)		Mortality (n=23)	Survival (n=236)	
Age, y			1			.75
<1 y	9 (75)	67 (79.8)		5 (21.7)	46 (19.6)	
1 to <6 y	3 (25)	17 (20.2)		10 (43.5)	143 (60.6)	
6 to <12 y	0	0		6 (26.1)	33 (13.9)	
12 to <18 y	0	0		2 (8.7)	14 (5.9)	
Gender			.115			.216
Male	5 (41.7)	56 (66.7)		12 (52.2)	159 (67.4)	
Female	7 (58.3)	28 (33.3)		11 (47.8)	77 (32.6)	
LOS in ICU	24.75±25.67	17.23±23.67	.12	11.9±10.8	6.7±6.2	.034*
Severe ISS (25–75)	12 (100)	56 (66.7)	.04*	23 (100)	9 (3.8)	<.01*
Etiologies						
Injury of the central nervous system	12 (100)	72 (85.7)	.35	4 (17.5)	116 (49.1)	<.01*
Injury of the musculoskeletal system	0	4 (4.7)	.44	0	77 (32.7)	<.01*
Injury of the respiratory system	0	1 (1.2)	.7	17 (73.9)	12 (5.1)	<.01*
poisoning	0	2 (2.4)	.59	1 (4.3)	19 (8.1)	.82
Injury of the circulatory system	0	2 (2.4)	.58	0	0	
Injury of the digestive system	0	1 (1.2)	.7	1 (4.3)	10 (4.2)	.98
symptoms, signs and ill-defined conditions	0	2 (2.4)	.58	0	2 (0.8)	.54

ICU=intensive care unit, LOS=length of stay.

(%): %

\*P<.05 was statistically significant.

information can help pediatricians identify potential etiologies in critically ill children with maltreatment and perform effective medical treatment immediately to improve the outcomes. On the basis of the mortality analysis of our study, we found that higher ISS was an indicator for poor clinical outcomes in both the abuse and neglect groups, but longer LOS in the ICUs and injuries of the CNS, musculoskeletal system, and respiratory system were predictors for mortality in the neglect group. AHI accounted for all the mortality in the abuse group and 14.2% of the mortality involving CNS injury, which was higher than the rates reported in previous studies from 6.7% to 25%.<sup>[7,14,15,19]</sup> Clinically, the pediatricians should be alert regarding the signs and symptoms associated with AHI and consult subspecialists such as radiologists, ophthalmologists, neurosurgeons, or neurologists to make a correct diagnosis immediately. In the neglect group, the mortality rate from injury of the respiratory system caused by drowning was higher than other etiologies. Severe hypoxic ischemic encephalopathy may occur after drowning and may account for highest mortality.<sup>[20]</sup> Previous studies have noted that improving the quality of critical care may promote higher survival rates and better outcomes in cases of child abuse.<sup>[11,21,22]</sup> Therefore, we believe that our results will be helpful for primary care clinicians who are involved in the management of critically ill cases of child maltreatment, because they highlight the importance of improving the quality of neurologic critical care for the prevention of associated mortality.

During our study period, even though the crude birth rate of Taiwan has been gradually decreasing since 2001, the rate of child maltreatment increased, which is similar to findings from Japan.<sup>[23,24]</sup> Our study showed that the number of cases of physical abuse and neglect has steadily increased since 2012. This trend may indicate the need for an emphasis on the issue of child protection by the government. Since 2011, our hospital has hosted many classes on child maltreatment nationwide. This strategy encourages people to improve their knowledge and awareness of child maltreatment and enhance the responsibility of medical staff in recognizing and diagnosing child abuse.

Nevertheless, there were some limitations in this study. First, given geographical and country differences in clinical practice, the different distribution of abuse types may exist. Second, the retrospective study was conducted only in 1 hospital, and different ICUs may exit different protocol of treatments for critically-ill victims. This may also lead to different outcomes. Third, for child neglect, the difference of recognition standard may exist due to the potentially different clinical judgments by primary clinicians, and some cases of neglect might be missed in this survey.

## 5. Conclusions

In the ICU, children in the abuse group had younger age, higher ISS, and worse neurologic outcome than those in the neglect group. Mortality occurred most often among infants in the abuse group and among preschool-age children in the neglect group. The ISS was a predictor for mortality in both the abuse and neglect groups, but the LOS in the ICU and injury of the CNS, musculoskeletal system, and respiratory system were indicators for mortality in the neglect group. Most importantly, identifying the epidemiological information may provide further strategies to

reduce the harm, lower the medical costs, and improve clinical care quality and outcomes in children with abuse.

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