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The Incidence of Child Maltreatment Resulting in Hospitalizations for Children Under Age Three

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Objective: To assess the incidence of child maltreatment-related hospitalizations for children under three for the population of Washington State.

Study design: A population-based study utilizing retrospective linked administrative data for all children born in Washington State from 2000 through 2013 (N = 1,191,802). The dataset comprised of linked birth and hospitalization records for the entire state. Child maltreatment-related hospitalizations were identified using diagnostic codes, both specifically attributed to and suggestive of maltreatment. Incidence were calculated for the population, by birth year, by sex, and by maltreatment subtype.

Results: A total of 3,885 hospitalizations related to child maltreatment were identified for an incidence of 10.87 per 10,000 person-years. Hospitalizations related to child maltreatment accounted for 2.1% of all hospitalizations for children under the age of three. This percentage doubled over time reaching a high in 2012 (3.6%). More than half of all hospitalizations were related to neglect. Maltreatment-related hospitalizations occurred most frequently in the first year of life for all subtypes except for neglect, which occurred the most between one and two years. Male children had higher incidence than female children in general (11.97 vs 9.70 per 10,000 person-years) and across all subtypes.

Conclusions: Hospitalizations can be a useful source of population-based child maltreatment surveillance. The identification of neglect-related hospitalizations, likely the result of supervisory neglect, as the most common subtype is an important finding for the development of prevention programming.

Abbreviations: child protection system (CPS); International Classification of Diseases, Ninth Revision (ICD-9);

Despite the breadth of the previously identified impacts[1] and costs[2-3] of child maltreatment, a primary challenge in addressing this problem is that the field still does not have a reliable way to estimate the number of children who experience child maltreatment[4-5].

Two common approaches to quantifying maltreatment rely on reports to child protection systems (CPS) and retrospective surveys of adults. These data sources are limited as it is highly unlikely that all maltreated children are reported to CPS[6] and retrospective surveys are constrained by memory bias and differences in definitions, as well as a lack of relevance to generational shifts in maltreatment[5]. The National Incidence Survey[6] addressed some of these drawbacks by also surveying professionals who may have identified cases of maltreatment regardless of the decision to report them to CPS. However, more than two-thirds of these surveyed professionals were mandated reporters from elementary and secondary schools. In contrast, more than one-quarter of reports to CPS concern children under three years old[7].

To address the lack of a single comprehensive data source on the incidence of maltreatment, hospital discharge records have been identified as valuable additional sources for surveillance of child maltreatment[8] because standardized codes are used to describe diagnoses[9]. A set of International Classification of Diseases, Ninth Revision (ICD-9) codes to identify child maltreatment was developed by Schnitzer et al, which addresses some of the shortfalls of solely relying on specific child maltreatment codes (995.50-995.59, E967, V7181, V715), such as the lack of a code related to neglect (beyond nutritional neglect (995.52) and general maltreatment (995.59)) and the reluctance of health professionals to use specific maltreatment codes[10,11-12]. The utility of hospital records with ICD-9 codes to ascertain the incidence of maltreatment can be enhanced when these records are linked with additional data sources. In particular, linking birth records to hospital records allows researchers to accurately identify which children

experience maltreatment in a specific population in order to estimate accurate incidence by accounting for multiple hospitalizations and children not part of the birth cohort of interest[13].

A number of studies have used linked administrative data to examine various aspects of populations interacting with CPS[14-16]. One published population-based study used linked administrative data including hospitalizations and birth records to measure comprehensive child maltreatment[17]. This study identified an incidence of 6.7 maltreatment-related hospitalizations per 10,000 births for children aged less than one year. This study has moved the field forward, but was limited in ways that future research should address, such as only examining maltreatment within the first year of life, being restricted to the children and hospitals of New York City, and not including the specific maltreatment codes.

In order to enhance the understanding of child maltreatment incidence, we used a dataset that linked all birth records with all hospital discharge records in the state of Washington from 2000 through 2013. The specific aims of this study were to determine the percentage of hospitalizations attributable to child maltreatment for children born in Washington under the age of three during the study time period, identify the incidence of child maltreatment-related hospitalizations in the population, and calculate the incidence by maltreatment category and by child sex, while identifying when the maltreatment hospitalization occurred by child's age category.

Methods

Data and Measures

We used a population-based dataset of linked birth record and hospital discharge administrative data for all children born in Washington State between 2000 and 2013 (N =

1,191,802). The sequential deterministic linkage methodology is described in Herman et al.[18] The dataset included 316,308 unique hospitalizations during this time period.

To identify the outcome of interest, a child maltreatment-related hospitalization, we examined the hospitalization discharge records. Hospitalizations needed to be associated with either a specific maltreatment code or a suggestive code without a co-occurring exclusion code as described by Schnitzer et al.[10] Each hospitalization in our data had up to 25 ICD-9 diagnostic codes plus an external cause of injury code (E-code). In addition to the ICD-9 codes that specifically indicated maltreatment (995.50-995.59, E967, V71.81, V71.5), we utilized the ICD-9 codes found to be suggestive of maltreatment by Schnitzer et al (presented by maltreatment categorization in the Appendix [available at www.jpeds.com]).[10] We followed the guidelines provided by these authors regarding co-occurring exclusion and inclusion ICD-9 codes and the maltreatment categorizations. Examples of exclusion codes include those related to motor vehicle accidents (E800- E819) and medical conditions such as bleeding disorders (286-287). In sum, the outcome of a child maltreatment-related hospitalization was indicated by the presence of a specific maltreatment code or the presence of a suggestive code combined with the absence of a co-occurring exclusion code.

We removed the secondary admissions on the same day for 14 children, likely the result of the child transferring to another hospital. Some children, 147, had multiple child maltreatment-related hospitalizations before their third birthday. As we could not determine if the reasons for children who had multiple hospitalizations were related to the first hospitalization or were new occurrences of maltreatment, we did not remove the subsequent hospitalizations.

We categorized each hospitalization by maltreatment subtype and the final categories were abuse, neglect, sexual abuse, undesignated maltreatment, and poly-type. We followed the

guidelines on maltreatment categorization by Schnitzer et al.[10] Hospitalizations that had diagnoses from multiple categories of maltreatment were labeled as "poly-type" maltreatment. The ICD-9 specific codes that did not indicate a type (995.50, 995.59, E967, and V71.81) were included in the "undesignated maltreatment" category, which Schnitzer et al labeled as "neglect or physical maltreatment."[10] The code for shaken baby syndrome (995.55) was included in the physical abuse category. The emotional/psychological abuse codes were included with the neglect category.

The other variables of interest are hospitalization year, birth year, child sex assigned at birth, and age in years (from birth to age 3). We chose three as a cutoff because nationally, the fatality and victimization rates are highest for children under three[7].

Analysis

All data analysis was conducted using R version 3.5.0[19]. After we identified the maltreatment-related hospitalizations based on the ICD-9 codes, we calculated the percentage of all hospitalizations for children under the age of three that were related to maltreatment by hospitalization year and by maltreatment code type (specific or suggestive). We calculated the incidence for children under age three per 10,000 person-years by birth year and by maltreatment subtype (neglect, undesignated, poly-type, and abuse). Sexual abuse incidence was not calculated due to fewer than ten cases identified. In order to identify the unique number of children who experienced a maltreatment-related hospitalization, we calculated the incidence proportion, also known as cumulative incidence[20], which is the number of children experiencing a maltreatment-related hospitalization within the first three years of life divided by the number of children in the cohort.

We calculated the incidence per 10,000 person-years for four different time periods: within the first three years of life, for the first year, for the second year, and the third year. We calculated the incidence by maltreatment subtype and the four time periods.

The frequency and incidence for children under age three per 10,000 person-years were calculated by maltreatment subtype and the child's sex. The incidence per 10,000 person-years were calculated based on the number of births by child sex from the birth record data.

This study was approved via the Washington State Institutional Review Board.

Results

We identified a total of 3,885 hospitalizations related to maltreatment for children under the age of three born in Washington State from 2000 until 2013 for an incidence of 10.87 hospitalizations under age three per 10,000 person-years. The number of unique children experiencing one of these hospitalizations within the first three years of life was 3,738 for an incidence proportion of 31.4 per 10,000 births. This may be an underestimate as we do not have three full years of data for children born between 2011-2013. Based on calculations using the complete 2010 numbers, the incidence could be up to 12% higher than our final results demonstrate. We identified an additional 1,548 hospitalizations that were identified as maltreatment-related but were not associated with a child linked to a Washington State birth record and therefore, not included in our analysis. A table with the counts per diagnostic code and maltreatment category is available in the Appendix.

The Figure presents both the percentages of hospitalizations related to child maltreatment by hospitalization year and the incidence by birth year over the study time period. There are two lines in the graph on the left: the dark line includes both the ICD-9 codes identified as suggestive of maltreatment by Schnitzer et al and the specific maltreatment ICD-9 codes (995.50-995.59,

E967, V7181, V715) and the lighter line is comprised of just the specific maltreatment codes.[10] The dark line in the graph on the left shows that the percentages of hospitalizations for children under the age of three related to child maltreatment more than doubled from 2003 (1.5%) to the year 2012 (3.6%) (linear regression: slope = 0.22, $p < .001$, $R^2 = 0.94$). This doubling of percentage over time was also observed for hospitalizations related to just specific maltreatment codes (the lighter line) from the year 2003 (0.3%) to 2013 (0.6%) (linear regression: slope = 0.03, $p < .001$, $R^2 = 0.95$). The graph on the right is the child maltreatment-related hospitalization under age three incidence per 10,000 person years by birth year and by maltreatment type. The darkest line includes all maltreatment types and the next darkest line is the most common maltreatment subtype of neglect. The lowest incidence for all maltreatment types was for birth year 2003 at 7.24 per 10,000 person-years and the highest for birth year 2010 at 16.8 per 10,000 person-years (linear regression: slope = 1.00, $p <.001$, $R^2 = 0.90$). The incidence for neglect was lowest in was 4.04 per 10,000 person-years in 2000 and highest in 2010 at 10.40 per 10,000 person-years.

Table I presents the frequencies and incidence by maltreatment subtype and age category. We removed sexual maltreatment from the table because we identified just eight hospitalizations related to this subtype. The most frequent type of child maltreatment-related hospitalization was for neglect at 2,239 (incidence of 6.26 per 10,000 person-years), which is 57.6% of all these hospitalizations. Following the classification of Schnitzer et al, the ICD-9 codes indicating neglect included burns, drownings, poisonings, and kidney injuries (see Appendix A for the full list of ICD-9 codes, descriptions, and counts organized by subtype).[10] Many of these codes appear to be likely related to supervisory neglect. The most frequent time period was before the child's first birthday with 1,854 hospitalizations, accounting for 47.7% of the total. The first year

of a child's life continued to be the most frequent time for all of the subcategories, with the exception of neglect, which had the highest frequency during a child's second year (965) compared with the first year (647) and third year (627).

Hospitalizations with multiple types ("poly-type") of child maltreatment diagnoses were indicated for 573 children (incidence of 1.60 per 10,000 person-years), with the most frequent time period during the first year. The most common (75.7%) combination for the poly-type category was abuse and undesignated, with another 10.7% of this category comprised of abuse, undesignated, and neglect diagnostic codes.

The undesignated category of maltreatment-related diagnoses had a total of 791 hospitalizations (incidence of 2.21 per 10,000 person-years), with a large decline from the first year of life (558) to the second year (134). Sexual abuse-related hospitalizations were the least frequent subtype of maltreatment-related hospitalizations with a total of eight. However, there were more diagnoses indicating sexual abuse used in this population, as 10 of the hospitalizations under the poly-type category had a sexual abuse diagnosis.

Table 2 shows the frequency and incidence of child maltreatment-related hospitalizations by maltreatment type and child assigned sex at birth. Across all subtypes, male children had higher incidence of hospitalizations related to maltreatment before the age of three than female children. This was true overall, where male children had an incidence of 11.98 compared with the incidence for females at 9.70 per 10,000 person-years, and across each of the subtypes with the largest difference identified in neglect-related hospitalizations (male: 6.79; female: 5.71 per 10,000 person-years).

Discussion

This study describes the incidence of hospitalizations related to child maltreatment under the age of three for the population of a U.S. state. Specifically, we found an incidence of 10.87 per 10,000 person-years based on 3,885 hospitalizations related to maltreatment. We identified that maltreatment was associated with 1.5% and 3.6% of all hospitalizations of children under the age of three for a given year between 2003 and 2013. For context, we examined the number of children within the same population who were hospitalized for motor vehicle accidents (ICD-9 diagnostic codes E810-E819). We identified 237 children for an incidence of 0.58 per 10,000 person-years for children under age three. This represented 0.2% of hospitalizations of children under the age three born in Washington State between 2003 and 2013.

The identification of an upward trend of the percent of hospitalizations related to maltreatment and incidence for children under age 3 among the entire population is an important one. Nationally, during this time period, there were decreases in the rates of allegations of maltreatment being substantiated by government CPS agencies (also known as the victimization rate)[22-23]. These decreases were more pronounced for physical and sexual abuse than neglect[24]. The increases we observed in maltreatment-related hospitalization could be related to actual increases in maltreatment occurrences, but could also be the result of changes in coding practices or better recognition of child maltreatment. Another possible explanation is a change in practice that resulted in an increase of hospitalization for children with child maltreatment-related injuries. Similarly, the decreases in substantiations[22-23] by CPS could reflect decreases in actual maltreatment occurrences, but could also be the product of a reduction of system resources during the Great Recession. In Washington State there was a $32 million decrease in spending by the state government on wages for state children and family services from the 2007-2009 biennium to the 2011-2013 biennium[25], which may have resulted in a rise of the substantiation

threshold[26]. These results highlight the importance of measuring maltreatment from more than one source.

These population-based results were higher in comparison with the 6.7 hospitalizations per 10,000 births found in the only other population-based study of maltreatment-related hospitalizations using linked birth records that we are aware of by Mason et al in New York City (NYC).[15] That NYC study included all births and hospitalizations in the first year of life in between 1995 and 2004[17]. Child maltreatment was identified using suggestive codes only in the NYC study (no specific codes) for hospitalizations that occurred in NYC hospitals. We found an incidence of 15.57 child maltreatment-related hospitalizations under the age of one per 10,000 person-years in Washington State using both suggestive and specific maltreatment codes. When we restricted our results to just suggestive codes within the first year of life in our study, we identified 1,321 hospitalizations for an incidence of 11.08 per 10,000 person-years, still higher than the NYC study. These differences may indicate actual differences in the populations, but may also be reflective of the different time periods that the studies were conducted in, given the steady increase in maltreatment-related hospitalizations we found and the later years our study covered.

Our results (10.87 per 10,000 person-years under age three and 15.57 per 10,000 person-years under age one) are also higher than previous studies of various types of physical abuse-related hospitalizations that relied on the specific maltreatment codes. An incidence of 2.36 injury abuse-related hospitalizations per 10,000 children through age three was identified using a national sample of hospitalizations from 1999-2007[9]. Another national study using hospitalization data from 2006 found an incidence of abuse-related injuries of 5.82 per 10,000 children for children under one year of age and 2.84 per 10,000 for children under three years of

age[27]. A study of maltreatment-related fractures using a nationwide sample found an incidence of 1.53 per 10,000 children under age three[21]. Incidence of abusive head injuries has been identified as ranging from 2.8 to 4.0 per 10,000 children under age one in national studies of hospitalization records[28-29] and 3.4 per 10,000 children under age two in Alaska using combined datasets[16]. Congruent with prior research that has identified an underuse of maltreatment codes[11-12, 30] and our findings that neglect was the most common subtype of maltreatment, the results from prior studies focused on specifically coded physical maltreatment were all far lower than the findings of our broader study. The narrower set of diagnostic codes, including the required presence of a specific maltreatment code, used by all of these studies makes our higher incidence findings unsurprising. Further, it is difficult to make direct comparisons with our category of physical maltreatment with these studies because some of the codes that are included as physical maltreatment (such as skull vault fracture (800) and pelvic fracture (808)) by other studies[9,21], are categorized as undesignated and neglect, respectively, by Schnitzer et al.[10]

Our study also identified that the majority (57.6%) of hospitalizations related to child maltreatment were categorized as neglect. This finding is consistent with trends for CPS across the U.S. where reports and victims are highest for neglect[7]. This is a compelling finding especially given that the only specific ICD-9 codes in regards to neglect are “child emotional/psychological abuse” (995.51), “child neglect (nutritional)” (995.52), “other child abuse and neglect” (995.59), and “evaluation for abuse and neglect” (V71.81). These codes were used infrequently in the hospital records data, with the most common code being child neglect (nutritional) with 79 cases identified. Thus, most of the hospitalizations related to neglect are the result of the use of the codes suggestive of maltreatment rather than specific codes.

Many of the hospitalizations suggestive of neglect are related to supervisory neglect and preventable injuries[10]. Encompassed in supervisory neglect is inadequate supervision, which can result in serious consequences[31]. Although there is no consensus on the definition of neglect, one of the most common elements included in state legal definitions of neglect is supervisory neglect[32]. This codification of supervisory neglect in legal definitions by the majority of state legislatures in addition to the large number of children hospitalized with injuries likely related to supervisory neglect demonstrates the importance and frequency of this form of maltreatment. Although the ICD-9 does not have a code specifically related to supervisory neglect, the ICD-10 addresses this shortcoming by including a code, Z62.0, which is "inadequate parental supervision and control"[8]. Other ICD-10 codes related to neglect include T74.0, Y06, Z62.4, and Z62.5[8]. Implementation of the ICD-10 codes in the U.S. started on October 1, 2015, therefore future identification of neglect through diagnostic codes may be achieved through specific ICD-10 codes more than they have been attainable through maltreatment-specific ICD-9 codes. In other words, codes suggestive of maltreatment may not be as necessary when using ICD-10 because of the inclusion of codes like Z62.0 for supervisory neglect.

The implication that many of the neglect hospitalizations were related to supervisory neglect is supported by the finding that neglect-related hospitalization incidence was highest during a child's second year, in contrast to all of the other subtypes of maltreatment. This is the time frame in a child's development when they are becoming more ambulatory and independent, including walking. This skill development requires a change in the supervision that a parent provides, which may change in a short amount of time as a child's skills progress and increase[32]. Services and education dealing with these changes may assist parents in responding to these developmental changes in order to keep children safe and free from injury.

This study demonstrates some of the utility of using linked administrative data from different sectors[34]. This longitudinal dataset allowed us to examine which children from the specific statewide population were hospitalized for child maltreatment over a critical timeframe using data that is already being collected by the state public health agency. Further, we were able to identify the unique number of children who experienced these types of hospitalizations, an advantage over datasets that only contain information on hospitalizations[17]. Future research should examine risk factors and CPS system involvement between children who experience child maltreatment-related hospitalizations and those who do not.

This study has at least five limitations. First, we used data from one state and it is unclear how generalizable this information is beyond Washington State. Future research should use similar approaches in different states to examine and compare the incidence of child maltreatment-related hospitalizations. Second, although ICD-9 codes are used across jurisdictions and with standardized definitions, it is unclear if they are coded uniformly across hospitals and practitioners. Thus, differences in coding practices and standards by the ICD coders and different hospitals may influence our results. A study of four children's hospitals found variation in the coding of abuse between those hospitals[35]. Future research should examine the variability of coding among all hospitals, including general hospitals. Third, our data are limited to children admitted to hospitals and do not include emergency department visits where children are not formally admitted, which were not available to us, restricting the medical interactions we are able to include in our study. Future research should incorporate emergency department visits wherever possible to provide a broader accounting of the incidence of maltreatment. Fourth, there are likely children who experienced a child maltreatment-related hospitalization but were not included in our analysis because they emigrated out-of-state.

Although we focused on children under the age of three rather than children of all ages may have somewhat curbed the potential underestimation of maltreatment, it is still likely that we were not able to include some children in our analysis because of this movement. Finally, child maltreatment cases are complex and the professionals interacting with these cases take into consideration far more information than can be contained in administrative data. Our analyses are unable to account for all the intricacies that are contained in these cases.

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Table 1. *Incidence of All Child Maltreatment-Related Hospitalizations by Subtype and Age*

	All (0-3 years)		< 1 year		1-2 years		2-3 years	
	n	Rate	n	Rate	n	Rate	n	Rate
Neglect	2239	6.26	647	5.43	965	8.10	627	5.26
Undesignated	791	2.21	558	4.68	134	1.12	99	0.83
Poly-Type	573	1.60	443	3.72	71	0.60	59	0.50
Abuse	274	0.77	206	1.73	46	0.39	22	0.18
All Types	3885	10.87	1856	15.57	1220	10.24	809	6.79

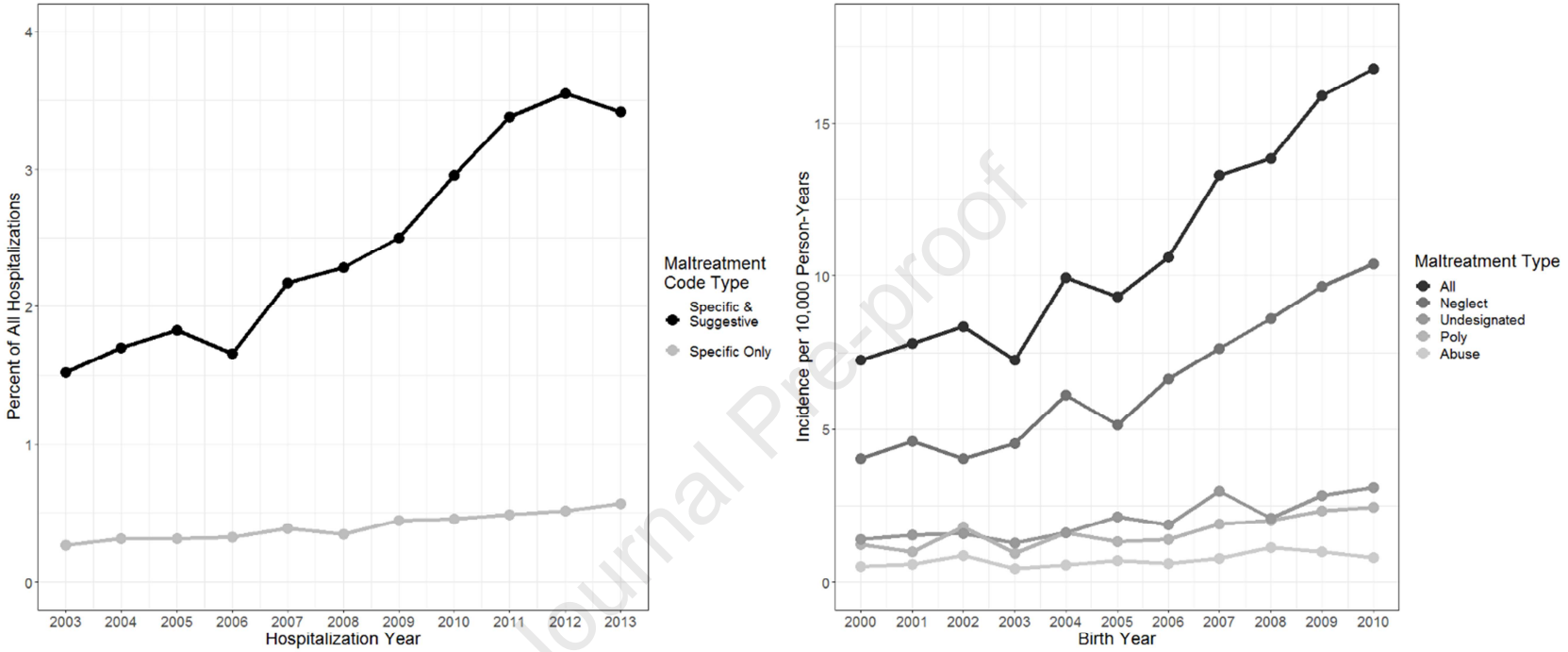
Notes: Incidence are per 10,000 person-years; Results in this table include both specific and suggestive maltreatment codes.

Table 2. *Incidence of Child Maltreatment-Related Hospitalizations by Subtype and Sex*

	All Types		Abuse		Neglect		Undesignated		Poly-Type	
	n	Rate	n	Rate	n	Rate	n	Rate	n	Rate
Female	1689	9.70	105	0.60	995	5.71	354	2.03	232	1.33
Male	2196	11.98	169	0.92	1244	6.79	437	2.38	341	1.86
Total	3885	10.87	274	0.77	2239	6.26	791	2.21	573	1.60

Note: Incidence are per 10,000 person-years; Results in this table include both specific and suggestive maltreatment codes.

Figure 1. Percent of All Hospitalizations Related to Maltreatment and Child Maltreatment-Related Hospitalization Incidence for Washington State-Born Children under Age Three (2003-2013).



Notes: The percent of hospitalizations starts in 2003 because years 2000, 2001, and 2002 do not include all hospitalizations for children under age 3 as data only includes births starting in the year 2000. Similarly, the graph of incidence does not include birth years 2011, 2012, and 2013 because we do not have three years of hospitalization data for these children. Specific child maltreatment hospitalization type includes the ICD-9 maltreatment codes (995.50-995.59, E967, V7181, V715) while suggestive are those identified as suggestive of maltreatment by Schnitzer et al. (2011). Maltreatment types include both specific and suggestive codes.