Title: Assessing the concordance of health and child protection data for 'maltreated' and 'unintentionally injured' children

Author names and affiliations:

Kirsten McKenzie[1] Debbie Scott[1], Jennifer A Fraser[2], Michael P Dunne[3]

1. National Centre for Health Information Research and Training, School of Public Health, Queensland University of Technology, Victoria Park Road, Kelvin Grove QLD Australia 4059
2. Sydney Nursing School, University of Sydney, NSW, Australia 2006
3. School of Public Health, Queensland University of Technology, Victoria Park Road, Kelvin Grove QLD Australia 4059

Corresponding author.

Dr Kirsten McKenzie, National Centre for Health Information Research and Training, School of Public Health, Queensland University of Technology, Victoria Park Road, Kelvin Grove QLD Australia 4059 k.mckenzie@qut.edu.au

Phone: +61 7 3138 9753

Fax: +61 7 3138 5515

Keywords: Child maltreatment, ICD, data linkage, hospitalisation, child protection

Word Count: Abstract 251, Text 5492

Abstract

Objectives To quantify the concordance of hospital child maltreatment data with child protection service (CPS) records and identify factors associated with linkage.

Methods Multivariable logistic regression analysis was conducted following retrospective medical record review and database linkage of 884 child records from 20 hospitals and the CPS in Queensland, Australia.

Results Nearly all children with hospital assigned maltreatment codes (93.1%) had a CPS record. Of these, 85.1% had a recent notification. 29% of the linked maltreatment group (n=113) were not known to CPS prior to the hospital presentation.

Almost 1/3 of children with unintentional injury hospital codes were known to CPS. Just over 24% of the linked unintentional injury group (n=34) were not known to CPS prior to the hospital presentation but became known during or after discharge from hospital. These estimates are higher than the 2006/07 annual rate of 2.39% of children being notified to CPS. Rural children were more likely to link to CPS, and children were over 3 times more likely to link if the index injury documentation included additional diagnoses or factors affecting their health.

Conclusions The system for referring maltreatment cases to CPS is generally efficient, although up to 1 in 15 children had codes for maltreatment but could not be linked to CPS data. The high proportion of children with unintentional injury codes who linked to CPS suggests clinicians and hospital-based child protection staff should be supported by further education and training to ensure children at risk are being detected by the child protection system.

Introduction

Child maltreatment is a major public health problem worldwide. Integrated health and welfare systems for early identification and intervention should form part of broader societal efforts for primary and secondary prevention. The World Health Organization has argued for improved uniformity in the reporting of child maltreatment-related injuries and deaths, and has emphasised the importance of health professionals in the assessment of suspected child maltreatment (1).

There are indications that up to 10% of all children presenting to an Emergency Department (ED) may be victims of child maltreatment (2). Without identification, 35% may be re-injured and up to 5% may die from subsequent injuries (2). Recent linkage of hospital data and child protection services (CPS) data in a Western Australian birth cohort found the likelihood of substantiations of child maltreatment increased 1.74 times for each single hospital admission per year. Children with a discharge diagnosis of a mental or behavioural disorder had 26 times greater likelihood of substantiated child maltreatment and those with coded unintentional injury or poisoning were 21 times more likely than other hospitalised children to have substantiated maltreatment at a later date (3).

The utility of standardised coded health data could be improved through systematic documentation of clinical suspicions of maltreatment as evidence shows the completeness of documentation of risk factors, injury characteristics and suspicions of maltreatment by clinical staff is often inadequate. In an ED record review of children under three years of age presenting with fractures, Ziegler et al found only 20% had documentation indicating consideration of a diagnosis of maltreatment and 27% lacked the documentation for assessment of consistency of the injury with the case history (4). Even in cases with a

diagnosis of maltreatment, Limbos et al found no documentation of the injury history in 45% and, in over a quarter of cases, no description of physical examination findings (5).

Efficiency of child maltreatment reporting systems can be assessed through linkage of hospital records with CPS data. While neither system provides a complete capture of cases, concordance of database records provide insight into the 'missed' cases. A Western Australian study of linked hospital and CPS records found that 90% of children with a maltreatment-related admission were known to CPS (with around 30% of cases being notified to the department for the first time at the hospital event). In Missouri, Schnitzer et al found that hospitalisation data on maltreatment linked very well to CPS data (88% concordance) but it remained that nearly one child in every eight maltreated children (12%) recorded in hospitals were not recorded on the CPS database. Missed children were more likely to be infants, female, attending hospitals in urban settings and African American (6).

Winn et al found 25% of intentional injuries to children were not coded as assault-related using ICD external cause codes and concluded that assault-related external cause codes were specific (99.7% specificity) but not sensitive (74.6% sensitivity) (7). Given the highly specific nature of maltreatment coding, a variety of diagnosis and external cause ICD codes have been used in an attempt to better identify cases of child maltreatment in health data sets (8).

Although referral of maltreated children to CPS appears to be quite efficient, to date supportive research has been limited to just a few locations. System-wide research into concordance of data from hospitals and CPS is crucial. Previous linkage research has largely focused on routinely coded administrative data, with few studies reviewing source records to obtain detailed insight regarding risk factors and injury circumstances. Thus, the aim of this study was to quantify the concordance of health and CPS data and to identify and compare a

range of predictors of linkage for children with maltreatment-related hospitalisations and unintentional injury-related hospitalisations in Queensland, Australia.

Methods

A retrospective hospital record review and data linkage to Child Protection Service (CPS) records provided information for this study.

Sample selection

urbanThe aim of hospital selection was to identify a range of large (>=30,000 admissions/year), medium (10,000-29,999 admissions/year) and small (<10,000 admissions/ year) caseload public hospitals from urban (i.e. major cities), rural (i.e. non-urban regions), and remote (i.e. towns considerably removed from major service areas) areas throughout Queensland. Eligible hospitals for inclusion in the stratified random sampling process were those that: were categorised as a public hospital, had an emergency department and an acute care service, treated paediatric patients, and had more than 1000 admissions per year (53 of 99 Queensland public hospitals with an emergency department satisfied all criteria).It was estimated that approximately 20 hospitals across Queensland could be sampled based on the resources available (budget, time, staff). Within this sample, the aim was to collect a sample of patient records from an equal number of large, medium, and small hospitals, and the final sample included 7 large hospitals, 7 medium hospitals and 6 small hospitals. from large and medium hospitals and 6 from small hospital. Approval was granted by ethics committees at Queensland University of Technology, the Queensland Health Department and all participating hospital districts.

Selection of cases (i.e. hospital discharges) from within each selected hospital was conducted by health department staff using the state hospital discharge database which contains ICD

coded diagnosis, procedure and external cause data for all discharges. Data from January 2003 to December 2006 for children aged up to 18 years were used. This captured data for 2 years before and after Queensland nurses were mandated to report child abuse.

Individual patient records coded for child maltreatment were rare, at 0.3% of hospitalisations in Australia in 2005/06 for children having any maltreatment code assigned (9). A random sampling approach would not provide sufficient maltreatment-related cases for review. Therefore, two independent samples of cases were obtained, with the first containing cases with any maltreatment codes assigned and the second containing cases with unintentional injury codes assigned. A comprehensive review of the ICD-10-AM classification system was undertaken to identify codes indicative of maltreatment, including review of index terms, a free text search of tabular volumes, and a review of coding standards pertaining to child maltreatment coding (9, 10). The maltreatment sample included children with a range of ICD-10 codes indicative of maltreatment as listed below .

- T74 Maltreatment Syndrome
- an ICD-10-AM external cause code in the range X85-Y09 Assault codes, where the perpetrator was identified at the fifth-digit with a value of 1 Parent, 2 Other family member, or 3 Carer for 15 to 17 year old children or a fifth-digit with a value of 1 Parent, 2 Other family member, 3 Carer, 8 Other specified person, or 9 Unspecified person for patients under 15 years of age
- Z04.4 Examination and observation following alleged rape and seduction
- Z04.5 Examination and observation following other inflicted injury
- Z61.4 Problems related to alleged sexual abuse of child by person within primary support group

- Z61.5 Problems related to alleged sexual abuse of child by person outside primary support group
- Z61.6 Problems related to alleged physical abuse of child
- Z62.0 Inadequate parental supervision and control
- Z62.3 Hostility towards and scapegoating of child
- Z62.4 Emotional neglect of child
- Z62.5 Other problems related to neglect in upbringing
- Z62.6 Inappropriate parental pressure and other abnormal qualities of upbringing
- an ACHI procedure code of 5830600 Radiography of the whole skeleton or 9608400 Physical abuse/ violence/ assault counselling reported in any of the procedure codes assigned.

The unintentional injury sample was drawn from cases admitted to hospital with a principal diagnosis of an injury with an external cause in the unintentional cause code range (V00-X59) excluding possible or definitive maltreatment. Cases with any maltreatment code were grouped together for analysis, but a variable was created to flag whether the code was for definitive maltreatment (assigned a T74 maltreatment code or an external cause of assault code with the perpetrator/age specifications described above) or possible maltreatment (assigned any of the other remaining maltreatment codes described above).

To take into account the caseloads of different hospitals, the number of cases (i.e. hospital discharges) for selection at each hospital was stratified according to the size of the hospital. The sample size for hospital discharge records was determined by a number of factors, including budget, resources and statistical power considerations, with an initial target of 500 cases per maltreatment code group (i.e. definitive maltreatment, possible maltreatment,

unintentional injury). Initial screening of the hospital data however, identified 511 eligible maltreatment-related code (definitive and possible) cases in the four year period in the hospitals according to the caseload ratio, and as such all of these cases were selected for inclusion in this sample. The caseload approach was however used for selecting the random sample of 500 cases of unintentional injury (from a base population of 46,341 children coded with unintentional injury).

Data collection process

Health department staff extracted unit record numbers (URN) of individuals and provided these to staff at each hospital, who extracted medical records for the researchers to review onsite. Excerpts from the Queensland Health training manual for Child Abuse and Neglect education (11) and from the International Classification of External Causes of Injury manual (12) were included in a data collection manual to highlight which relevant risk indicators should be extracted and documented. Medical records of the index event of all cases were reviewed and structured text excerpts extracted. Text extracts were reviewed by two researchers (KM and DS) and coded to indicate the presence or absence of documentation relevant to risk factors. Those factors captured through the review of the documentation which were considered to indicate a heightened risk for child maltreatment if present (based on child maltreatment literature) were coded with a value of 1 if present and a value of 0 if not present in the documentation. Two aggregate variables were also created which identified the presence/absence of *any* risk factors and the sum of all risk factors documented (maximum value=25 with 25 risk factors all allocated a value of 0 or 1):

- Event – Child's disclosure of abuse, documentation regarding consistency of injury event, documentation regarding presentation delay, documentation regarding witnesses to event, referral to SCAN/DCS documented
- History - History of abuse, History of foster care, Previous presentation at hospital, Known to DCS
- Health/behavioural- Poor physical appearance, Behavioural cues of abuse, Poor general health
- Protective- Lack of protective parent
- Substance abuse-Drug abuse, Alcohol abuse
- Disabilities-Physical disabilities, Intellectual disabilities, Mental health issues
- Socioeconomic-Socioeconomic problems, Homelessness, Transience
- Criminal-Criminal history, Police involvement
- Family relationship – Relationship instability, Domestic violence.

Data linkage

A dataset containing the researchers' project ID and identifying details of the child was provided by the health department to CPS. An experienced CPS client intake officer conducted the linkage manually, using procedures normal CPS intake procedures. This manual process was necessary as there are multiple fields stored in a relational database, and information is recorded about each child, including all known aliases, all previous addresses, and different variations of dates of birth (including estimated ages where dates of birth were not available). Hence, an automated linkage process was not feasible given the heterogeneity and complexity of data requiring interpretation.

The CPS officer recorded a unique identifier for each matched case against the researchers' Project ID and provided this spreadsheet to the Information Systems analyst who extracted,

for each matched case, data regarding the circumstances of the incident with the closest contact date *prior to* the date of presentation at the hospital and the closest contact date *following* the date of presentation at the hospital. De-identified data were then provided to the researcher to enable the merging of this data with the de-identified health dataset.

Data analysis

Forward stepwise logistic regression using the likelihood ratio method was used, controlling for age, gender, hospital size and hospital locality, with analyses conducted separately for the two samples (Any Maltreatment Codes and Unintentional Injury Codes). Independent variables were included in the model if they were statistically associated at $p<0.10$ and if there were more than 5 cases in the linkage cell total (to address issues of small cell sizes in the multivariate model). Independent variables which were tested initially included:

- Age (continuous);
- Gender (binary – male/female);
- Hospital size (categorical - large, medium, small);
- Hospital locality (categorical - urban, rural, remote);
- Presence of formal report to child protection in hospital records (binary - yes/no);
- Delay in presentation from injury date noted in hospital records to presentation date documented in records (binary - yes/no);
- ICD chapter for principal diagnosis (categorical);
- Presence of code from each chapter of the ICD as an additional diagnosis (multiple binary variables for each chapter– yes/no to indicate if code present);
- Presence of abuse type coded (multiple binary variables to indicate presence of each abuse type (neglect, physical, sexual, psychological, other) – yes/no to indicate if code present);

- Perpetrator coded (categorical – no perpetrator coded, parent/family member/carer coded, other perpetrator coded);
- Maltreatment certainty (binary – definite/possible) (only for analysis for maltreatment sample);
- Body region of injury and nature of injury included as an interaction term in the regression (categorical Barell row matrix values (head/neck region and fractures used as referent categories with head/neck fractures considered one of the more serious maltreatment indicator diagnoses));
- Risk factors (multiple binary variables to indicate presence/absence of each individual risk factor as well as two aggregate risk factor variables to indicate a) presence/absence of *any* risk factor and b) sum of all risk factors).

Two dependent variables were examined for each sample: a) whether the child who presented at hospital matched a CPS record or not and b) whether the child matched to a recent CPS event at the time of hospital presentation ("recent" was defined as six months before and after the index hospital discharge to capture those children who had 'active' CP cases in the CP system during the period when hospitalisation occurred compared to those children with 'non-active' CP concerns). If a child becomes known to CPS, their data are retained indefinitely, so the first dependent variable captured all children who were known at any time in their lives up to the period at which data linkage occurred in March/April 2010. The second dependent variable used a more restrictive time period for linkage to examine whether the child who presented at hospital matched a recent CPS event. As 93.1% of cases (n=394/423) with an assigned maltreatment code matched a CPS record, the logistic regression for any match to CPS for the maltreatment code sample could not be conducted due to small cell sizes. Frequencies, percentages and crude odds ratios for significant variables at a univariate level are reported for this dependent variable, and a logistic

regression for the recent linkage is reported. For the unintentional injury sample, both logistic regressions were able to be performed.

Some unintentionally injured or maltreated children present to hospitals multiple times. To satisfy the criterion of independence between observations, where a child had multiple hospital presentations, only the first presentation was included in the analyses. Linearity of continuous variables was assessed and non-linear variables were categorised into groups and treated as categorical variables in the model. Results are presented using ORs and 95% CIs. SPSS version 18.0 was used to conduct all analyses.

Finally, the authors deliberately chose not to include an outcome variable to indicate whether cases were recorded as substantiated cases of maltreatment or not in the CP system for this analysis. The rationale for deliberate exclusion of this variable was that there is a considerable difference in the threshold for defining 'maltreatment' and 'harm' between the health and CP systems in Queensland (13), and as the focus of this paper was on the concordance of 'concerns' of child maltreatment between the two systems, not necessarily concordance of 'definitions' of maltreatment, the focus of analysis was on the proportion 'known' to both departments.

Results

Sample Characteristics

There were 461 children in the unintentional injury code sample and 423 unique children in the maltreatment code sample for which data could be reviewed (the remaining cases were unable to be included in the study as their medical records were unavailable at the point of data collection at the hospitals). Table 1 shows the linkage results, with 93% of the maltreatment code sample and 32% of the unintentional injury code sample matching a

record in the CPS data. Restricting the time period for linkage to only include cases where a CPS record was recent (within 6 months before or after hospitalisation) reduced the proportion of hospital coded maltreatment cases that linked to 85%. Eleven percent of the children with unintentional injury codes linked to a recent CPS record.

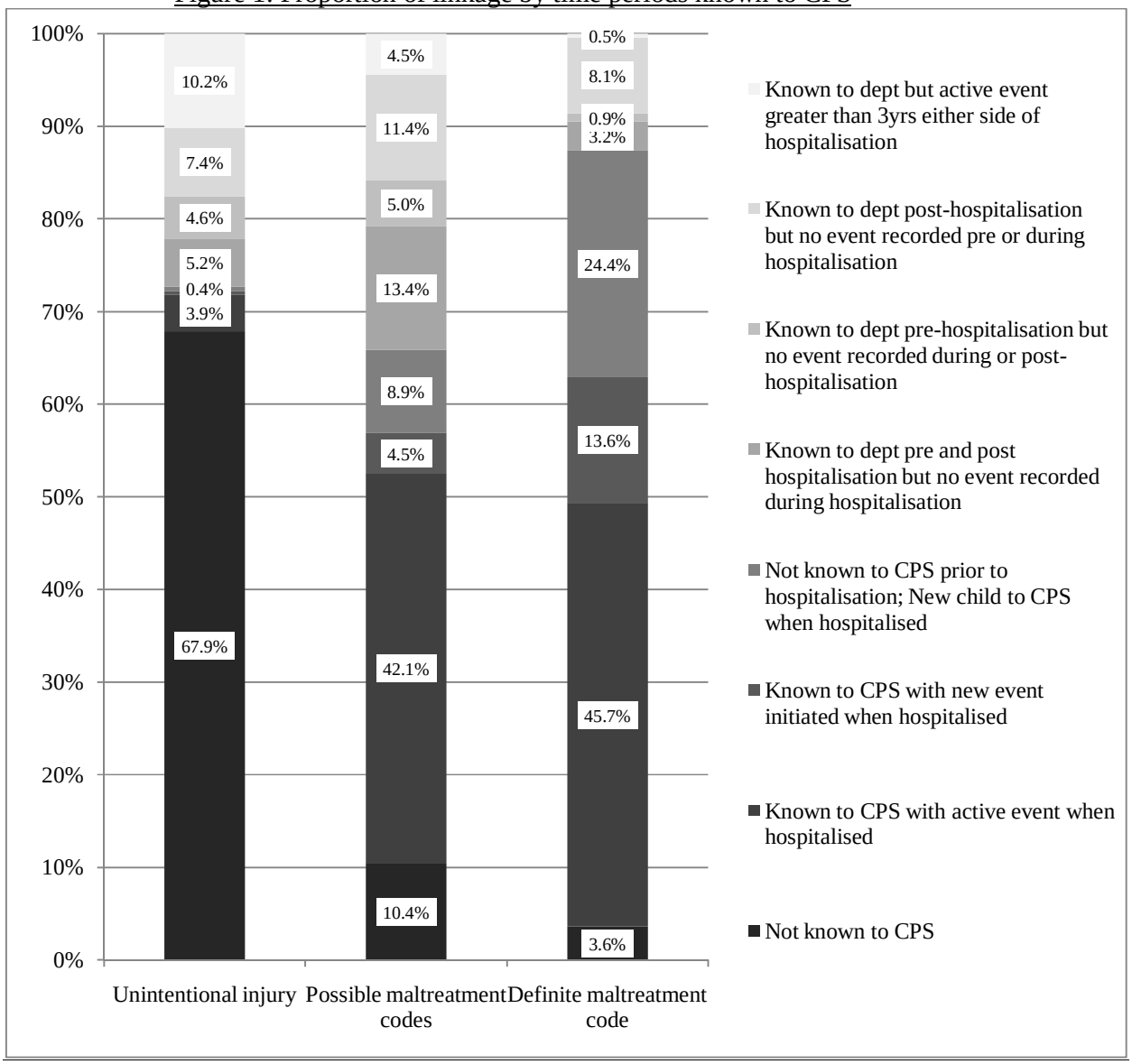
Further examination of the time periods within which children became known to CPS was conducted (See Figure 1). Twenty nine percent of the linked maltreatment group (n=113) were not known to CPS prior to the hospital presentation but became known to the department either during hospitalisation (n=72) or anytime after discharge from hospital (n=41). About four in every five (78%) of those in the maltreatment sample identified anytime after discharge (n=32) had their first CPS event recorded within a year. Just over 24% of the linked unintentional injury group (n=34) were not known to CPS prior to the hospital presentation but became known either during hospitalisation (n=2) or post discharge from hospital (n=32). The age group, gender, hospital size and locality characteristics are reported in each of the logistic regression tables in subsequent sections.

Table 1: Linkage between hospital data and CPS data for each sample

Linkage between hospital and CPS data	Unintentional injury code sample		Any maltreatment code sample	
	n	%	n	%
Known to CPS				
No	313	67.90%	29	6.86%
Yes	148	32.10%	394	93.14%
Recent CPS event*				
No	410	88.94%	63	14.89%
Yes	51	11.06%	360	85.11%
TOTAL	461	100.0%	423	100.0%

*Recent CPS event refers to the recording of an event on the CPS system either 6 months before, during or 6 months after the index hospital admission.

Figure 1: Proportion of linkage by time periods known to CPS



Linkage of Coded Maltreatment-Related Cases to CPS

Overall, 394 (93.1%) of the 423 children with hospital coded maltreatment were known to CPS. As such, multivariate modelling for unlinked cases could not be conducted due to small cell sizes, so univariate statistically significant results and crude odds ratios only are presented in Table 2. The univariate predictors of being known to CPS were younger age group, documentation of a referral to the hospital child protection team or CPS, the number

of risk factors documented, additional diagnosis code(s) from the ICD-10 'factors affecting health status' chapter (Ch 21), and the certainty of the ICD maltreatment code assigned were strongly associated with linkage to a recent CPS event (See Table 2).

Of those cases with a recent event recorded in CPS data, 360 (85.1%) of the 423 hospital cases were linked. After controlling for age, sex, hospital size and locality and after mutual adjustment for all variables included in the model, the following predictors were identified (See Table 2; Note: Variables which were significant for the analysis of case known to CPS are shown in the table, but those which weren't statistically significant for the analysis of recent CPS events are identified with the phrase 'not significant'). Children under the age of 1 were more than 6 times more likely than children aged 15-17 to link to a recent CPS event. Compared to children who were not documented as being referred to the hospital child protection team or to CPS, children who were documented as being referred were 3.5 times more likely to link to a recent CPS event. Relative to children with no additional diagnosis from the 'Factors affecting health status' ICD-10 chapter, children with an additional diagnosis from this chapter were 4.5 times more likely to link to a recent CPS event The number of risk factors documented was weakly associated with linkage to a recent CPS event. Children assigned a definitive maltreatment code were 4.3 times more likely to have a recent CPS event recorded than children assigned a possible maltreatment code.

Table 2: Demographic variables and predictors of linkage to CPS for maltreatment sample

			Known to CPS		Recent CPS event	
Variable	Values	Number of cases	% Linked	Crude odds ratio (95% CI)	% Linked	Adjusted odds ratio (95% CI)
Age group	<1 years old	86	96.51%	referent	93.02%	referent*
	1-5 years old	117	94.87%	0.67 (0.16-2.75)	88.03%	0.55 (0.17-1.78)
	6-9 years old	44	95.45%	0.76 (0.12-4.71)	79.55%	0.27 (0.07-1.06)
	10-14 years old	113	92.03%	0.42 (0.11-1.59)	85.84%	0.35 (0.09-1.25)
	15-17 years old	63	85.71%	0.22** (0.05-0.83)	71.43%	0.15** (0.04-0.61)
Gender	Male	153	94.11%	referent	84.31%	referent
	Female	270	92.59%	0.78 (0.35-1.76)	85.56%	1.49 (0.75-2.97)
Hospital size	Large	231	92.64%	referent	87.45%	referent
	Medium	152	92.76%	1.02 (0.46-2.24)	80.26%	0.94 (0.44-1.88)
	Small	40	97.50%	3.09 (0.40-23.96)	90.00%	4.34 (0.60-31.29)
Hospital locality	Urban	245	91.84%	referent	82.86%	referent
	Rural	156	94.23%	1.45 (0.64-3.28)	87.82%	0.76 (0.36-1.61)
	Remote	22	100.0%	not rep# not rep#	90.91%	0.33 (0.02-4.53)
Known to CPS documented	No	250	90.00%	referent**	78.40%	˜not in final model
	Yes	173	97.69%	4.69 (1.60-13.75)	94.80%	
Referral to hosp CP unit or CPS	No	152	90.13%	referent*	70.39%	referent**
	Yes	271	94.83%	2.01 (0.94-4.28)	93.36%	3.53 (1.55-8.06)
Number of risk factors in record	(continuous)	No link	2.93 (avg) (SD 1.75)	1.53 (1.22-1.92)**	2.94 (avg) (SD 1.63)	1.44 (1.16-1.79)**
		Link	4.52 (avg) (SD 2.14)		4.67 (avg) (SD 2.13)	
Ch 4 Endocrine, nutritional, metabolic disorders asadditional diagnosis	No	412	93.69%	referent**	85.44%	˜not significant and not in final model
	Yes	11	72.72%	0.18 (0.04-0.72)	72.72%	
Ch 19 Injuries and poisonings as additional diagnosis	No	266	90.98%	referent**	81.20%	˜not in final model
	Yes	157	96.81%	3.01 (1.13-8.07)	91.72%	
Ch 21 Factors affecting health status codes as additional diagnosis	No	196	92.86%	˜not significant	88.27%	referent**
	Yes	227	93.39%		82.38%	4.55 (1.56-13.29)
Certainty of maltreatment code	Possible	202	89.60%	referent**	76.73%	referent**
	Definite	221	96.38%	3.09 (1.34-7.14)	92.76%	4.32 (1.72-10.89)
Code for 'other or unspecified' abuse	No	312	91.35%	referent**	81.41%	˜not in final model
	Yes	111	98.20%	5.16 (1.21-22.08)	95.49%	
Perpetrator code	No assault code	223	90.58%	referent	79.82%	˜not in final model
	Parent, family, carer	141	98.58%	7.22 (1.67-31.31)**	95.03%	
	Other/unspecified perpetrator	59	89.83%	0.92 (0.35-2.39)	81.35%	

**Significant at p<0.05 level

*Significant at p<0.10 level

#Inflated odd s ratio due to small cell sizes, value not reported

˜Not significant/ not in final multivariate model

Linkage of Children with Unintentional Injury codes to the CPS dataset

Overall, 148 (32.1%) of the 461 cases who were admitted to hospital with injury coded as being due to an unintentional cause were known to CPS. After controlling for age, sex, hospital size and locality, and after mutual adjustment for all variables included in the model, the following predictors were identified (See Table 3). The odds of linkage to CPS for children discharged from rural hospitals were 1.68 times higher than for children from urban hospitals. Children who presented after the introduction of mandatory reporting for nurses were 1.64 times more likely than those presenting before this legislation was introduced to be known to CPS. Compared to children where no delay in hospital presentation for the injury was documented, children with a documented delay were 1.71 times more likely to be known to CPS. Those for whom any risk factors were mentioned in the record had a 2.7-fold likelihood of being known to CPS than children with none of the risk factors documented. Relative to children with no additional diagnosis from the Chapter 21 'Factors affecting health status' ICD-10 chapter, children with an additional diagnosis from this chapter were almost 4 times more likely to be known to CPS.

Of the children with hospital unintentional injury codes, 51 (11.1%) linked to a recent CPS event. In the multivariable model, , the following predictors were identified (See Table 3). The odds of linkage to a recent CPS event for children discharged from rural hospitals was 2.4 times higher than for children from an urban hospital. Compared to those not documented as being known to CPS, children who were documented as being known to CPS were 50 times more likely to link to a recent CPS event.

Relative to children with no additional ICD-10 diagnoses, children with an additional diagnosis from Chapter 21 were 6.4 times more likely to link to a recent CPS event. Children with a coded superficial contusion of the extremity had almost a 12-fold higher likelihood of

linking to a recent CPS event compared to children with a fractured head or neck, and children with a coded poisoning had almost a four-fold higher likelihood of linking to a recent event.

Table 3: Demographic variables and predictors of linkage to CPS for unintentional injury sample

			Known to CPS			Recent CPS event		
Variable	Values	Number of cases	% Linked	Adjusted odds ratio (95% CI)		% Linked	Adjusted odds ratio (95% CI)	
Age group	<1 years old	18	27.78%	referent		5.56%	referent	
	1-5 years old	120	33.33%	2.05	(0.60-6.97)	14.17%	7.88	0.70-88.19
	6-9 years old	96	28.12%	1.61	(0.45-5.69)	9.38%	3.92	0.34-45.08
	10-14 years old	122	31.97%	2.01	(0.58-6.92)	12.30%	5.81	0.53-63.61
	15-17 years old	105	35.24%	1.63	(0.46-5.75)	8.57%	2.37	0.20-28.19
Gender	Male	305	32.10%	referent		10.82%	referent	
	Female	156	32.10%	0.91	(0.57-1.44)	11.54%	0.91	0.45-1.84
Hospital size	Large	223	33.18%	referent		11.21%	referent	
	Medium	173	30.64%	0.88	(0.54-1.43)	9.83%	0.93	0.44-1.94
	Small	65	32.31%	0.72	(0.33-1.57)	13.85%	1.09	0.38-3.14
Hospital locality	Urban	266	29.32%	referent		8.65%	referent**	
	Rural	179	35.75%	1.68**	(1.03-2.75)	15.08%	2.41**	1.15-5.07
	Remote	16	37.50%	1.72	(0.44-6.74)	6.25%	0.26	0.15-4.51
Before/after mandatory report	Before legislation	300	29.00%	referent**		9.33%	˜not in final model	
	After legislation	161	37.89%	1.64	(1.05-2.54)	14.28%		
Known to CPS documented	No	451	30.82%	#removed from model		9.76%	referent**	
	Yes	10	90.00%			70.00%	50.44	7.57-336.13
Delay in presentation	No	367	29.97%	referent**		10.90%	˜not in final model	
	Yes	94	40.43%	1.71	(1.01-2.90)	11.70%		
Any risk factor documentation	No risk factors	398	29.14%	referent**		8.79%	˜not in final model	
	One or more risks	63	50.79%	2.73	(1.48-5.02)	25.39%		
Ch 21 Factors affecting health status codes as additional diagnosis	No	434	30.41%	referent**		9.91%	referent**	
	Yes	27	59.26%	3.87	(1.56-9.58)	29.63%	6.45	1.93-21.51
Body region* Nature of injury∞	Fracture* Head/Neck	20	15.00%	referent		15.00%	referent**	
	Contusion* Extremities	7	57.14%	3.44	(0.71-16.65)	42.86%	12.06	2.12-68.42
	Fracture* Head/Neck	20	15.00%	referent		15.00%	referent**	
	Poisoning*Systemwide	16	43.75%	1.46	(0.45-4.73)	31.25%	3.83	1.07-13.67

**Significant at p<0.05 level

˜Not significant/ not in final multivariate model

∞Only significant interactions shown

#Removed from model as small cell size inflated odds ratio leading to poor model fit

Discussion

The integrated system for concerns about child maltreatment in this Australian state, whereby children classified in hospitals as maltreated are reported to the CPS, appears to be relatively concordant in the great majority of cases in which maltreatment is coded, with 93.1% of these children being known to CPS. The high rate of linkage is similar to the findings of research in Western Australia (5). Nearly one in five of the linked children in the present study were identified for the first time during the period of hospitalisation, highlighting the importance of systematic monitoring and referral from hospitals. However, around one in every fifteen children with a maltreatment code (6.9%) did not link to the CPS and consideration should be given to whether these children have slipped through the safety net. A proportion of these cases may represent difficulties in linkage (possibly where children have multiple aliases or transient living circumstances making tracking through the system difficult). However, the identified characteristics of children less likely to link to a recent CPS event were: being of an older age, without a documented referral to DCS, with fewer risk factors documented, with a code indicating there were other factors affecting the child's health status and with less definitive maltreatment codes. The majority of these presentations were not for the treatment of an acute injury but for examination of a suspicion of abuse or treatment of problems associated with abuse (i.e. mental and behavioural). It is not surprising that the cases where documentation is less certain, where there are fewer documented risks identified, and where there is a lack of definitive conclusion don't link to CPS as these cases may not have reached a threshold of certainty to prompt a report to be made. The unlinked cases that reflect longer histories of abuse are concerning, as these cases may represent children who have been missed by the system over the course of their lives. In both instances, review of these cases is warranted to ensure that appropriate responses have been made, both during the episode of care, as well as in terms of the longer term system response to the child.

This analysis also indicates the scale of the difficulty for services in providing effective CPS responses to prevent maltreatment. Just over 80% of the linked hospitalised children were already known to CPS prior to admission, with the index hospitalisation coded with a relatively equal proportion of neglect, physical abuse and sexual abuse . Although this study could not provide insight into how much nor what type of maltreatment is prevented by CPS services, it is clear that being known to the CPS *per se* was not preventive of maltreatment for many affected children. Future system-level evaluations of effectiveness could utilise similar data-linkage designs and compare such statistics as key indicators of outcomes over time.

Importantly, one-third of children who presented with an injury coded as being due to an unintentional cause were known to CPS, with 11% of this sample having a recent CPS event recorded (only 2 of which were recorded during the hospitalisation episode), similar linkage proportions to those seen in Missouri (14). The annual rate of CPS notifications in Queensland in 2006/07 was reported as being 2.39% of children (15), therefore the proportion of children with 'unintentional injury' with a CPS record was over 4 times higher than the baseline population rate for notifications. This indicates that the possibility of maltreatment histories should be at least considered for children presenting with an unintentional injury.

Analysis of predictors of linkage for those coded with unintentional injury were revealing. Children were more likely to link to CPS if they presented for treatment at a rural compared to an urban hospital. This is consistent with a report from the Queensland Commission for Children and Young People, where notification rates are higher in rural Queensland (15). Children with codes of unintentional injury were also more likely to link to CPS if they had additional diagnoses from the 'Chapter 21 Factors affecting health status' chapter recorded (11% of linked cases) compared to having no additional diagnoses of this nature recorded (3.5% of unlinked cases). Codes in this chapter are used when "circumstances other than a

disease, injury or external cause classifiable to categories A00–Y89 are recorded as 'diagnoses' or 'problems.... (a) When a person who may or may not be sick encounters the health services for some specific purpose, such as to receive limited care or service for a current condition.... (b) When some circumstance or problem is present which influences the person's health status but is not in itself a current illness or injury" (16). Hence, assignment of such codes in addition to injury diagnoses should be reviewed in hospital discharge data, as they may provide insight into other psycho-social circumstances affecting the patient. However, the use of these codes has not been tested or validated and as such, the degree of standardisation of use of these codes across facilities is uncertain.

There were some different predictors of 'any linkage' (i.e. whether the child was known to CPS at all) compared to linkage to a recent CPS event. Predictors of any linkage for children in the unintentional injury sample included: presenting after the introduction of mandatory reporting legislation for nurses, a documented delay in presentation, and documentation of any risk factors in the medical record. Such documentation may indicate that clinical staff had a suspicion of maltreatment or negligence surrounding the injury event, and documentation of known risk factors and delayed presentations enabled this concern to be communicated subtly to others involved in the care of the child. Previous research has found limited clinical documentation of histories, circumstances and risk factors to enable definitive categorisation of maltreatment, possible maltreatment or unintentional (17), and hence, where documentation does exist regarding risk factors, cases identified may be highly specific for maltreatment.

Furthermore, the finding that children were more likely to be known to CPS if they had an injury event after the introduction of nurses mandatory reporting legislation may indicate either a) that nurses are more likely to report cases where there is legislation requiring them to do so (18) (though cases may have been known to CPS before or after the hospitalisation

event and not necessarily as a result of the hospitalisation event) or b) a heightened attention on child maltreatment in the community upon the introduction of new legislation may have resulted in a greater number of reports across the community to better identify children at-risk of maltreatment. Due to privacy constraints, the information about the reporter of CP concerns was unable to be analysed and so further related analysis was not possible.

Predictors of linkage to a recent CPS event for those with unintentional injury included having documentation to indicate that the child was known to CPS and having a superficial contusion of the extremities or an injury due to a poisoning coded. Children with a superficial contusion of the extremities were 12 times more likely than children with head/neck fractures to link to a current CPS event. For this code to be assigned, documentation in the medical record would need to state that there was bruising of the arms or legs. Given that many of these children were admitted to hospital for the treatment of a more severe type of injury (such as a fracture/open wound etc), the fact that bruising on the arms or legs is also documented could be taken as an indicator of suspicion of additional/previous injuries, and hence an indicator of suspected maltreatment (19, 20).

The high proportion of cases treated for unintentional injury that linked to CPS provides support for claims that children presenting for an unintentional injury are at increased risk for maltreatment (21, 22). To what extent the risk profiles for both groups can be matched is uncertain. However, presentation for unintentional injury particularly in the context of supervisory neglect may be useful in predicting other forms of neglect and/or abuse (23). Of course, injuries can occur while children are adequately supervised. Likewise, inadequately supervised children are not always injured. These results indicate that although the construct of supervisory neglect is controversial in relation to unintentional injury in children, it may demonstrate strong predictive validity in future research.

Further, parental supervision should be assessed when children are admitted for injuries classified as unintentional to establish risk for child abuse and neglect and need for early intervention and prevention (23, 24). The capacity of prevention efforts to reduce the burden of child injury relies on the ability to recognise and assess risk. Supervisory neglect is recognised as a form of child neglect. Its recognition and classification has received much research attention in the past decade in large part due to the explosion of mandatory reporting laws compelling medical and hospital staff to report suspicion of abuse or neglect to child protection authorities (25, 26).

Children presenting to paediatric emergency departments with unintentional injury could be flagged for risk assessment and referral to programs such as home visiting (27) and paediatric emergency department interventions (28) which have strong research support. While children are referred if child abuse or neglect is suspected or known, a broader approach to risk and in particular to problems of parental supervision is needed to address the link between unintentional harm to a child and CPS referral demonstrated in our study.

There are some limitations to this study. Possibly, some of the unlinked cases represented children who actually had a CPS record which could not be located in the matching process. Some of the children may have been known to the CPS system in other States or Territories in Australia. Further, ethical concerns precluded the collection of data on Indigenous status and postcode as one of the factors for consideration in the logistic regression. Indigenous status is highly correlated with rural locality. Finally, we were not able to obtain actual counts of the number of children in Queensland who are known to the CPS system on an annual basis to enable the calculation of population rates as this data is not routinely available from the CPS database.

The health department in Queensland has mandatory reporting processes and compulsory staff education across the State to systematise the reporting process, and the CP system in Queensland utilises an integrated decision making tool to systematise the assessment of children for whom reports are made across regions. However identification, assessment and decision processes and the subsequent concordance of data across systems ultimately relies on the experience and expertise of staff in both departments and the comprehensiveness and relevance of documentation. The Queensland CPS has recently changed the child safety legislation to extend the definition of 'Harm' to include cumulative harm defined as "a series or combination of acts, omissions or circumstances" (13). Ensuring health staff are aware of the importance of documenting risk factors and reporting concerns to CPS to enable the identification of early indicators of cumulative harm will become an increasingly important to ensure targeted early intervention is possible. Furthermore, for an appropriate public health response, researchers and policy makers interpreting the data need to focus on improvement of routine collection of hospital discharge data to enable appropriate analysis and interpretation to identify risks, assess change over time and further develop secondary prevention strategies and services.

Key Messages

What is already known on this subject:

- Research suggests up to 10% of all children presenting to an Emergency Department (ED) may be victims of child maltreatment and the World Health Organisation has recently argued for more uniform reporting of child injuries and death related to maltreatment.
- The utility of standardised coded health data could be improved through systematic documentation of clinical suspicions of maltreatment as research evidence shows the completeness of documentation is often inadequate.
- The concordance of child maltreatment reporting systems can be assessed through linkage of hospital records with CPS data, though there has been limited research using this method to date.

What this study adds:

- The hospital system for reporting children to CPS appears to be concordant in the great majority of cases in which maltreatment is coded, with similar linkage rates identified to previous research.
- This study also indicates the scale of the difficulty for services in providing effective CPS responses to prevent maltreatment, with just over 80% of the linked hospitalised children already known to CPS prior to admission.
- Importantly, one-third of children who presented with an injury coded as being due to an unintentional cause were known to CPS, with 11% of this sample having a recent CPS event recorded. This indicates that the possibility of maltreatment histories should be at least considered for children presenting with an unintentional injury.

Acknowledgements: We wish to acknowledge the substantial work of Garry Waller and Margaret Campbell who collected and coded the hospital data used in this study, and the Department of Communities Staff (especially Alouise Van Sleeuwen) who facilitated and performed the linkage of records.

Competing Interests Statement: All authors declare that they have no competing interests to declare.

Sources of Support: This work was supported by an Australian Research Council Linkage Grant (grant number LP0882093), with industry partner support from Department of Communities, Queensland Health and Abused Child Trust.

References

1. Arie S. WHO takes up issue of child abuse. Br Med J. 2005 July 16, 2005;331(7509):129-.
2. Mace SE, Gerardi MJ, Dietrich AM, Knazik SR, Mulligan-Smith D, Sweeney RL, et al. Injury prevention and control in children. Annals of emergency medicine. [REview]. 2001;38(4):405-15.
3. O'Donnell M, Nassar N, Leonard H, Jacoby P, Mathews R, Patterson Y, et al. Rates and types of hospitalisations of children with subsequent contact with the Child Protection System: A population based case-control study. Journal of Epidemiology and Community Health. 2009;ePub(23 Sept 2009).
4. Ziegler DS, Sammut J, Piper AC. Assessment and follow-up of suspected child abuse in preschool children with fractures seen in a general hospital emergency department. J Paediatr Child Health. 2005;41(5-6):251-5.
5. Limbos MA, Berkowitz CD. Documentation of child physical abuse: how far have we come? Pediatrics. 1998 07;102(1 Pt 1):53-8.
6. Schnitzer PG, Slusher P, Van Tuinen M. Child Maltreatment in Missouri: Combining Data for Public Health Surveillance. American Journal of Preventative Medicine. 2004;27(5):379–84.
7. Winn DG, Agran PF, Anderson CL. Sensitivity of Hospitals E-Coded Data in Identifying Causes of Childrens Violence-Related Injuries. Public Health Rep. 1995 May-Jun;110(3):277-81.
8. Scott D, Tonmyr L, Fraser J, Walker S, K. M. The utility and challenges of using ICD codes in child maltreatment research: A review of existing literature. . Child Abuse and Neglect. 2009;33(11):791-808.
9. McKenzie K, Scott D. Using Routinely Collected Hospital Data for Child Maltreatment Surveillance: Issues, Methods and Patterns. BMC Public Health. 2011;11(7).
10. McKenzie K, Scott D, Waller G, Campell M. Reliability of Routinely Collected Hospital Data for Child Maltreatment Surveillance. BMC Public Health. 2010;11(8).
11. Child Safety Unit. Child Abuse and Neglect - Education Module One. Brisbane: Queensland Health; 2005 Contract No.: Document Number|.
12. ICECI Coordination and Maintenance Group. International Classification of External Causes of Injuries (ICECI) version 1.2.: Consumer Safety Institute, Amsterdam and AIHW National Injury Surveillance Unit, Adelaide; 2004.
13. Child Protection and Other Acts Amendment Bill 2010. (2010).
14. Spivey M, Schnitzer P, Kruse R, Slusher P, Jaffe D. Association of Injury Visits in Children and Child Maltreatment Reports. The Journal of Emergency Medicine. 2008;32(2):207-14.
15. Commission for Children and Young People and Child Guardian Queensland. Child Guardian Report: Child Protection System 2008–09. Brisbane: Commission for Children and Young People and Child Guardian Queensland; 2010 [cited. Available from: http://www.ccypcg.qld.gov.au/pdf/publications/reports/child_guardian_report_08-09/CG-Report-2008-09-full.pdf.
16. National Centre for Classification in Health (NCCH). The International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification (ICD-10-AM). Sixth Edition ed. Sydney: University of Sydney; 2008.
17. Oral R, Blum KL, Johnson C. Fractures in young children: are physicians in the emergency department and orthopedic clinics adequately screening for possible abuse? Pediatric Emergency Care. 2003 06;19(3):148-53.
18. Fraser JA, Mathews B, Walsh K, Chen L, Dunne M. Factors influencing child abuse and neglect recognition and reporting by nurses: a multivariate analysis. Int J Nurs Stud. 2010 Feb;47(2):146-53.
19. Spencer D. Paediatric trauma: when it is not an accident. Accid Emerg Nurs. 2002;10:143-8.
20. Keshavarz R, Kawashima R, Low C. Child abuse and neglect presentations to a pediatric emergency department. J Emerg Med. 2002;23(4):341-5.
21. Morrongiello BA, Corbett M, McCourt M, Johnston N. Understanding unintentional injury-risk in young children. The nature and scope of caregiver supervision of children at home. Journal of Pediatric Psychology. 2006;31:529-39.
22. Peterson L, Brown D. Integrating child inury and abuse-neglect research: Case histories, etiologies, and solutions. Psychological Bulletin. 1994;116(2):293-315.
23. Hymel KP. When is lack of supervision neglect? . Pediatrics. 2010;118:1296-780.
24. Spinks AB, Scott D, Bain CJ, Nagle CM, Macpherson AK, McClure RJ. Parental attitudes to supervision and risk of childhood injury: results from a primary school cohort. International Journal of Injury Control and Safety Promotion. 2008;15(1):49 - 52.
25. Coohey C. Defining and classifying supervisory neglect. Child Maltreatment. 2003;8(2):145-56.
26. Coohey C. The nature of parental supervisory neglect. Child Welfare. 2008;87(4):55-77.

27. Whiteside-Mansell L, Johnson D, Aitken MM, Bokony PAC-B, N, McKelvey L. Head start and unintended injury: The use of the family map interview to document risk. Early Childhood Education Journal. 2010;38:33-41.
28. Dubowitz H, Feigelman S, Lane W, Kim J. Pediatric primary care to help prevent child maltreatment: The Safe Environment for Every Kid (SEEK) model. . Pediatrics. 2010;123:858-64.