Infant injury deaths with unknown intent: what else do we know?

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Abstract

Objectives—Strong evidence based on case record reviews indicates that the incidence of child homicide reported from death certificates is under ascertained. The characteristics of infant injury fatalities with undetermined, but suspicious, intent were compared for the probability that they should be considered homicides.

Methods—Using linked birth and death certificates for all birth cohorts in the US from 1983–91, 2345 injury fatalities reported as intentional, 7594 as unintentional, and 431 as undetermined intent were identified. Maternal and infant variables potentially predictive of injury fatalities were selected based on increased bivariate associations. Relative risks of injury death by intentional, unintentional, and undetermined intent were assessed for maternal and infant characteristics.

Results—Relative risks were consistently higher across all intent categories for infants of mothers with the least education, no prenatal care, young maternal age, and single marital status, as well as for infants who are second or later born, preterm, black, or American Indian. Fatalities with undetermined intent have larger relative risks in the highest risk categories than either intentional or unintentional injuries. Deaths with undetermined intent have risk profiles that more closely resemble profiles for intentional deaths than unintentional.

Conclusions—Injury homicide rates would be almost 20% greater than official classifications indicate if deaths with undetermined intent were included. In analyses of infant homicide, excluding deaths of undetermined intent may lead to an underestimation of the magnitude of the public health problem of intentional injuries among infants. Other studies based on record reviews from multiple sources indicate that misclassification and under ascertainment of homicides may be even greater.

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In 1996, 332 infants were recorded as dying of intentional injuries in the US.¹ Recent studies found risk factors for infant homicides are similar to risks for injuries classified as unintentional.^{2–3} Strength of the associations

varies by intent, although the strongest risk factors consistently include low maternal age or education, lack of prenatal care, premature birth, and being a second or later born infant.

Classification of deaths by intent is based on official designation of the underlying cause of death as specified on death certificates. Deaths considered suspicious by the medical examiner or coroner, but with insufficient evidence to determine intent, are reported as “undetermined intent”.⁴ In a recent comparative study of cause of death at all ages among 11 countries, the per cent of all injury deaths with undetermined intent ranged from 1% to 10%.⁵ Inconsistent lack of determination of intent affects assessment of relative rates of violent deaths among countries.

Previous studies in the US, based on case record reviews from multiple sources, have found strong evidence that overall incidence of child homicide is under counted by official sources.^{6–10} The study by McClain *et al* used estimates of misclassification from a Missouri case review study and Federal Bureau of Investigation information to project probable national levels of child and adolescent deaths from child abuse and neglect, concluding that about 85% of such deaths are recorded as due to other causes.⁷ Some studies include suspicious childhood deaths reported as “undetermined intent” on death certificates as homicides because of this evidence.^{3 11 12} However, none of these studies used epidemiological methods to predict probable misclassification based on profiles of infants at highest risk.

The purpose of this study is to determine whether injury deaths reported as undetermined intent have risk factor profiles that more closely resemble either intentional or unintentional fatalities. Using a unique database which links birth and death certificate information for infants, this epidemiological study is the first to compare intentionality of infant injury fatalities according to maternal and infant characteristics for all births in the US. Improved risk factor information about suspicious (undetermined) fatalities should lead to better identification of high risk infants and more timely interventions.

Methods

Linked birth and infant death certificate data from the National Center for Health Statistics (NCHS) were analyzed for the nearly 35 million US live births occurring from 1983–91. Methods of data linkage and file characteristics as produced by NCHS are reported elsewhere.¹³

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Table 1 Number and relative risk (RR) of injury fatalities for highest risk factors by intent

Factor	Intentional (n=2345)		Undetermined (n=431)		Unintentional (n=7594)	
	No	RR	No	RR	No	RR
First prenatal visit (months)*						
None	244	8.7	52	10.3	447	4.2
7-9	187	3.1	41	3.8	608	2.6
4-6	630	2.4	112	2.3	2031	2.0
1-3	1130	1.0	203	1.0	4287	1.0
Mother's education (years)*						
≤11	830	8.3	179	9.4	2724	5.8
12	742	4.0	131	3.7	2348	2.7
13-15	215	2.3	37	2.1	811	1.9
≥16	79	1.0	15	1.0	368	1.0
Mother's age (years)						
<17	162	5.6	27	5.3	366	3.1
17-19	578	4.5	106	4.8	1471	2.9
20-24	889	2.6	174	2.9	2899	2.1
≥25	716	1.0	124	1.0	2858	1.0
Mother's marital status						
Unmarried	1371	4.3	255	4.4	3355	2.4
Married	974	1.0	176	1.0	4239	1.0
Gestational age at birth (weeks)*						
<28	47	3.4	12	4.6	131	2.6
28-36	377	2.2	81	2.5	1154	1.9
≥37	1672	1.0	309	1.0	5917	1.0
Birth order*						
Third or subsequent child	648	1.1	139	1.5	2775	1.9
Second child	689	1.0	133	1.1	2466	1.4
First child	919	1.0	148	1.0	2295	1.0
Race						
Black	922	3.4	188	4.1	2176	2.1
American Indian	55	3.6	11	4.2	200	3.4
Asian	36	0.7	5	0.6	133	0.7
White or other	1332	1.0	227	1.0	5085	1.0

*For this factor, some data were missing or reported as unknown. Education was not reported in Texas and California in 1983-88 or in Washington in 1983-91.

Relative risks of infant injury death (age <1 year) based on injury fatality rates are compared for the unintentional, undetermined, and intentional injury groups by a variety of maternal and infant characteristics. All live births and infant deaths are kept in the analysis to determine rates, relative risks, and assessment of large enough numbers for stable rates.

Characteristics analyzed include mother's age, race, education, and marital status; trimester of pregnancy prenatal care began; gestational age; and live birth order. Variable selection is based on statistical methods described in previous analyses of high risk factors for both intentional and unintentional injuries using the same data files.^{2,3} Variable selection is limited to items available on the certificates. Many relevant social indicators, such as parental occupation or family structure, are not present from these data sources. For fatalities, the high per cent of missing data on father's characteristics (for example, age 33%, race 30%), necessitated the omission of father's risk factors from the analysis.

Gestational age and birth weight are highly correlated, with similar relative risks, so only gestational age at birth is kept in tables because of implications for timing of interventions during the prenatal period. For example, there are targeted interventions that after 28 weeks of gestation would miss the opportunity for prenatal interventions for infants born before that time. In addition, premature infants who are more susceptible to health problems may put additional stress on the family.

Determination of intent is based on official designation of the underlying cause of death on

death certificates, using the *International Classification of Diseases*, 9th revision (ICD-9), for external causes of death (E codes).¹⁴ Deaths considered unintentional are classified under E codes 800-949, and as intentional under E codes 960-969 (homicide and injury purposely inflicted by other persons). Deaths of undetermined intent are classified under E codes 980-989 (injury undetermined whether accidentally or purposely inflicted).

Results

Of 10 370 total injury deaths, 22.6% are reported as intentional (n=2345), 4.2% as undetermined intent (n=431), and 73.2% as unintentional (n=7594) (table 1). Relative risks of death are consistently higher across all intent categories for infants of mothers with the least education, no prenatal care, young maternal age, and single marital status. The same is true for infants who are third or later born, preterm, black, or American Indian.

Fatalities with undetermined intent have larger relative risks in the highest risk categories than either intentional or unintentional injuries for almost all variables examined. Only for birth order as third or later born is the relative risk for unintentional greater than either intentional or undetermined.

In addition, the risk profile for deaths with undetermined intent more closely resembled profiles for intentional deaths than unintentional. Among deaths with undetermined intent, the risks for infants born to mothers with less than 12 years of education are 9.4 times greater than for infants of mothers with ≥16 years whereas relative risks for intentional injuries and unintentional injuries are 8.3 and 5.8, respectively. Among infants born to mothers without prenatal care, the risks for undetermined intent are 10.3 times greater than for mothers obtaining care in the first trimester. The corresponding relative risks for intentional injuries and unintentional injuries are 8.7 and 4.2, respectively.

More recent data from linked files for 1995 were reviewed to verify these findings. (Linked files for 1992-94 are not available and because of the gap, 1995 data were not included in our study.) The same general trends were shown within broad categories but the number of fatalities were too small for the highest risk categories in cases with undetermined intent. Only 45 total cases were classified with undetermined intent in 1995 resulting in similar but statistically unreliable rates estimates.

Discussion

The striking similarity of levels of risk for suspicious deaths and deaths known to be intentional, suggests that many undetermined deaths may actually be homicides. This assessment agrees with results of earlier studies of under counting of homicides based on careful review of records from multiple sources.⁶⁻⁹

Even if deaths reported as undetermined for intent were combined with those reported as intentional, the resulting numbers are likely to

underestimate the true magnitude of the problem. Reviews of records from multiple sources, after the cause of death had been determined by a medical examiner, showed that substantiated child abuse or neglect may be involved in 7% to 27% of injury deaths reported as unintentional.⁶⁻⁸ At least 5% of deaths classified as sudden infant death syndrome may be due to child abuse and neglect.^{6,9}

Another death certificate classification that may include some intentional deaths is "deaths of unknown cause" or ICD code 799. This group includes deaths where no cause could be found or determination of cause was still pending when the database was closed for compilation of statistics (n=6446 for infants in 1983-91). Cases with legal findings still to be reported may be included in this group. Unfortunately, it is not possible to separate these out. Further comparison of specific country practices for determining intent and allocation of ICD code 799 for pending cases and unknown cause of death will enhance our ability to compare injury rates internationally.⁵

Better dissemination of results of child death review investigations of circumstances around fatalities also should improve the official reporting and description of risk factors and thereby facilitate development of better interventions.¹⁵ To improve quality of certificate data sources, physicians, medical examiners, and coroners should be encouraged to promptly file amended death certificates in cases where the cause of death was initially unknown or was changed after further investigation. Otherwise, these changes will not be reflected in available health statistics data.

This analysis of intentionality classification presented separate descriptors of characteristics such as race, maternal age, and marital status. No attempt was made to perform multi-level categorizations of variable cross classifications by intent because of very small numbers in the category strata for undetermined intent which represented 4.2% of all injury fatalities. An earlier multivariate analysis of predictive risk factors for homicides showed that effects of race were diminished, but still significant, when other social factors were accounted for.³ Unfortunately the small numbers and limited variables involved in this study do not permit a more in depth multivariate analysis of race and social status interactions.

It is possible that the assignment of intentional or undetermined intent by medical examiners or coroners is biased toward the higher risk factor profiles shown in this analysis. Another study found that professional health workers may be more likely to identify and report child abuse in lower class and black families than in other families with about half of serious abuse cases unreported.¹⁶ Similar risk factor profiles may cause the certifiers to question intent for lower socioeconomic groups more often than in cases occurring in middle or upper class families. Such considerations may result in some false positive identification of homicide or suspicious deaths consistent with the higher risk factors in this study. Similarly, under-reporting (false negatives)

may be prevalent in the higher socioeconomic groups. The effect of these biases on this analysis would be to further the misclassification of fatalities due to violence.

During 1983-91, 2345 infants were reported as intentionally killed and 431 died under suspicious circumstances—almost one a day. Deaths of undetermined intent are likely to represent intentional injuries. In analyses of infant homicide, excluding deaths of undetermined intent or merging them with unintentional injuries may lead to an underestimation of the magnitude of the public health problem of intentional injuries in infants.

Combining deaths reported as intentional and undetermined for intent provides more accurate estimates of the magnitude of violent deaths among infants and young children. The 1983-91 combined rate of intentional and suspicious fatalities is 8.0 per 100 000 births or 26.8% of all infant injury deaths compared with the reported rate of 6.7 per 100 000 (22.6%). Our findings suggest that estimates of infant homicide that incorporate deaths with undetermined (suspicious) intent on birth certificates could be almost 20% greater than reported rates of homicide.

We need better risk profiles to effectively target preventive services to the families where carefully planned interventions are most likely to be effective. Neither accurate risk profiles nor carefully planned interventions can be produced without linkage of information on families and fatality circumstances from social services, police investigators, health care providers, and medical examiners or coroners. Epidemiological studies are needed to describe the interactions among the effects of family structure, parental social support, alcohol, drug abuse, and other contributors. Lack of data and poor specificity in risk factors for violence against young children force us to rely on the crude measures available from existing information systems.

Birth certificates are limited to biological measures such as maternal age or infant's birth order, gestational age, and birth weight. In the US social measures such as parental education or race are available, but more pertinent information on family structure or social support, including parental occupation, are not. These social measures may be markers for, and indicative of, the lack of readily available care-taking and parenting resources that increase the risks of violence among infants and children. But without better information on specific family circumstances, documentation of increased risks for homicide according to the measures available may be the first step toward targeting interventions toward the highest risk groups. At the same time, the many homicides that occur among lower risk social groups may be neglected because of stereotyping. Both social service agencies and child fatality review teams need to organize and support improved information systems to facilitate prevention programs with appropriately targeted interventions.^{15 17 18}

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Editorial Board Member: brief biography

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Leon S Robertson, PhD, was a lecturer in epidemiology and public health at Yale University for 20 years before retirement in 1998. He previously served on the faculties of Harvard University Medical School and Wake Forest University and as senior behavioral scientist in the Insurance Institute for Highway Safety. He has coauthored six books and authored two: *Injuries: Causes, Control Strategies and Public Policy* (1983) and *Injury Epidemiology* (1992, second edition 1998). He has contributed more than 140 articles and chapters to the scientific literature. Dr Robertson was a member of the National Research Council (NRC)/Institute of Medicine committee on trauma research that produced the report *Injury in America: A Continuing Public Health Problem* and was vice chair of the NRC committee that reviewed the injury control program of the Centers for Disease Control. He also served on the NRC panel on occupational safety and health statistics and chaired the special interest group on injury control and emergency health services of the American Public Health Association. He is the recipient of the Distinguished Career Award from the association.