

Original Article

Availability of death review of children using death certificates and forensic autopsy results

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Highlights

- All child deaths in Shiga, Japan, were reviewed without obtaining parental consent.
- Death certificates and forensic autopsy results were combined.
- Most infant suffocations involved co-sleeping with the mother or breastfeeding.
- Basic information for implementing detailed methods for CDR was obtained.
- Legislation for collecting detailed information without parental consent is needed.

Abstract

The Model Project for Child Death Review (CDR) was initiated in Japan, but parental consent is required for detailed investigations. We proposed an alternative method to review child deaths using death certificates and forensic autopsy results when parental consent is not provided. We extracted and reviewed death certificates for the deceased younger than 18 years from among all certificates submitted in Shiga Prefecture between 2015 and 2017. In addition, we analyzed autopsy records in cases that underwent forensic autopsy. The prevalence of each cause of death was compared among age groups. The situation and circumstances of unnatural deaths were analyzed in detail. Of 131 certificates, unnatural deaths accounted for 29.7%. The prevalence of each cause of death significantly differed among age groups. Malignant disease and suicide were most common in school-aged children and congenital disease was most common in infants. Suicide was the leading cause of unnatural death, followed by suffocation, which was most common in infants. Situations where suffocation was reported included co-sleeping with the mother and breastfeeding. Despite parental consent not being obtained, the trends of regional child deaths and the circumstances of accidental deaths were clarified by the present method. However, the results of detailed investigation were lacking. This study provided basic information for implementing detailed methods and procedures for CDR at the governmental level. To perform optimal CDR, legislation for collecting detailed information without parental consent is required.

Keywords: Child Death Review (CDR); preventable child death; death certificate; forensic autopsy; suffocation; sleeping environment

Introduction

According to the World Health Organization (WHO), an estimated 5.2 million children under the age of 5 years died in 2019, mostly from preventable and treatable causes, along with an additional 500,000 older children (aged 5–9 years). Therefore, the United Nations adopted the Sustainable Development Goals to promote healthy lives and wellbeing for all children [1]. In Japan, the low birth rate and subsequent decrease in the population under the age of 15 over the last four decades have become a serious problem [2]. Against this background, saving the life of children should be a particularly high priority in Japan. To prevent child deaths, it is necessary to review these deaths by collecting information about the circumstances and causes of death. In some developed countries, including Australia, Canada, New Zealand, the UK, and the US, regional Child Death Review (CDR) committees review the circumstances and causes of all child deaths [3, 4]. With such data, these committees can make recommendations to government about changes to legislation, policies, or practices that could potentially reduce the risk of deaths occurring under similar circumstances. In Japan, the Japanese government has also promoted the prevention of preventable deaths in children. In December 2019, the Basic Act for Child and Maternal Health and Child Development came into force, followed by the Basic Act for Promoting the Determination of Cause of Death in April 2020. Both pieces of legislation mention promoting official CDR. Accordingly, the Ministry of Health, Labour

and Welfare (MHLW) initiated the Model Project for CDR in seven Japanese prefectures including Shiga Prefecture in 2020, which was intended to provide a foundation for the future spread of CDR throughout Japan [5]. In 2021, the MHLW revised the manual for the Model Project for CDR and stated that parental consent was required for detailed investigation of child deaths. This rule made the procedure of CDR difficult because consent was not provided in some cases, such as those involving abuse, mistreatment, or suicide. When parental consent is not obtained, the reviewer cannot ask for detailed information from other family members or medical staff with whom the decedents had consulted. Given the introduction of this rule, there is a need to understand what kind of information or information to what level of detail can be obtained in a death review without parental consent.

The review of death certificates for the purpose of improving public health can be performed with the permission of MHLW. Forensic autopsy results can also be used for epidemiological research with the protection of personal information under the permission of an institutional review board. Therefore, in cases where parental consent is not obtained for the CDR, we considered that a regional death review of children can be performed using death certificates and forensic autopsy results. We thus propose an alternative method of reviewing child deaths using death certificates and forensic autopsy results when parental consent is not obtained. Upon clarifying the benefits and limitations of this method, ideal countermeasures for CDR were proposed. Furthermore, according to the results, effective preventive measures for cases considered to involve preventable deaths were proposed.

Materials and Methods

Study design and patient selection

We extracted and reviewed death certificates for the decedents younger than 18 years from among all certificates submitted in Shiga Prefecture between 2015 and 2017. **Shiga Prefecture is located in the center of Japan with an area of 4017 km² and contains the largest lake in Japan, Lake Biwa.** In 2018, Shiga's population was 1,412,881 people, including 11,598 newborns. The result of a medical autopsy is shown on death certificates, while a forensic autopsy is performed for unnatural or unknown deaths. In this study, for cases where a forensic autopsy had been performed, detailed information was obtained from the autopsy records. Forensic autopsies are performed at only one facility in Shiga Prefecture, namely, the Department of Legal Medicine, Shiga University of Medical Science. Therefore, information on the autopsy records was provided by authors from this facility (MN, MT, MH). To review death certificates, approval from the MHLW was obtained. In addition, this study, including its review of forensic autopsy results, was conducted following approval from the Ethical Committee of Shiga University of Medical Science (R2020-164).

Statistical analysis

Data were summarized as values with proportions or frequencies for categorical variables. Chi-squared tests were used to compare prevalence rates of each cause of death between groups. Residual analyses were further performed. When the adjusted residual

value is > 1.96 , the rate is significantly higher than the expected frequency; when the value is < -1.96 , the rate is significantly lower than the expected frequency. Because the age of the victims did not follow a normal distribution, age of the group was shown as median and interquartile range. To determine the significance of differences of age between two groups, Mann–Whitney tests were conducted because variables were not normally distributed. A p -value ≤ 0.05 was considered statistically significant. All analyses were performed with SPSS version 23 (IBM, Chicago, IL, USA).

Results

In total, 38,902 death certificates were submitted to Shiga Prefecture in the 3 years from January 1, 2015, to December 31, 2017. Of these, 131 certificates were for cases younger than 18 years. The age distribution is shown in Figure 1. In six cases, the cause of death was shown as “under investigation.” However, the correct cause of death was obtained after reviewing forensic autopsy records. The causes of death were classified as natural, unnatural, and undetermined; unnatural deaths accounted for 22.9% of all deaths. The median (interquartile range) age of those who died from natural deaths was significantly younger than those from unnatural deaths [0.4 (0.0–4.3) years vs. 13.8 (0.9–15.8) years, $p < 0.0001$]. Based on previous studies, natural death was classified as due to infection, acute disease, chronic disease, malignant disease, perinatal disease, or congenital disease, and unnatural death was classified as due to homicide, suicide, traffic accident, suffocation, fire, and other [6]. Among the natural deaths, congenital disease was the most

common, followed by perinatal disease and malignant disease. For unnatural deaths, suicide was the most common cause, followed by suffocation.

Age at death was divided into four groups for each cause of death: newborns (younger than 1 month old), infants (1–11 months), toddlers (1–5 years), and school-aged children (6–17 years). The distribution of each cause of death was compared among these four age groups (Table 1). For natural deaths, acute disease, chronic disease, malignant disease, perinatal abnormalities, and congenital disease showed significant differences in prevalence among the age groups. Perinatal abnormalities were only found in neonates, whereas malignant disease and suicide were most common in school-aged children and congenital disease was most common in infants. For unnatural deaths, we found significant differences in prevalence among age groups for homicide, suicide, and suffocation. Suffocation was most common in infants.

Autopsies were performed for 38 cases (29.0%), including 13 medical autopsies and 25 forensic autopsies. In the 25 forensic autopsies, the cause of death was confirmed as infection in three cases, acute disease in five cases, chronic disease in one case, homicide in four cases, suicide in two cases, suffocation in seven cases, fire in one case, and undetermined in two cases (Table 2). In eight suicide cases, autopsy was not performed. For these cases, the cause of death was confirmed only by external examination by the coroner. Among the 25 cases of forensic autopsy, sudden unexpected death in infancy (SUDI) accounted for 15 cases. The leading cause of SUDI was suffocation (46.7%), followed by infection (20.0%), acute disease (13.3%), SIDS (6.7%), and unknown cause (6.7%).

Background information on the victims and the situations of the accidental deaths is summarized in Table 2. **Because all causes of suffocation were sleep-related infant death, the authors considered that these deaths would have been preventable if the sleep environment had been improved.**

Discussion

In cases of a hospital-controlled illness, the cause of death is shown on the death certificate. In cases of sudden unexpected death, further examination by the police and forensic autopsy are required. After these careful investigations, the true cause of sudden unexpected death may be determined as disease (e.g., infectious disease), arrhythmia-associated death, or unnatural death (e.g., suffocation, homicide, cerebral contusion). In this study, autopsies were performed for 38 cases (29.0% of all cases); most of them were forensic autopsies. Shiga Council for Promoting the Determination of Cause of Death recommends that the police and police doctors actively perform an autopsy on all children with sudden unexpected death. Therefore, all suffocation cases were diagnosed after forensic autopsies and police investigations. In view of this, accurate diagnoses of how death occurred should have been available in the present study.

SUDI describes any sudden and unexpected death, whether explained or unexplained, that occurs during infancy. The latter, where such sudden deaths may remain completely unexplained, has been classified as sudden infant death syndrome (SIDS) and defined as the sudden unexpected death of an infant younger than 1 year of age, with onset of the fatal episode that remains unexplained after a thorough investigation

including a complete autopsy and review of the circumstances of death and clinical history [7]. In the present study, we clarified the distribution of causes of death in SUDI from the autopsy results. As this study was performed in a certain region of Japan for 3 years, the results may be representative in Japan. The present results suggested that suffocation was the leading cause of SUDI and SIDS accounted for 6.7% of SUDI cases. According to a report from the Center for Disease Control and Prevention in the USA, SUDI cases had the following composition: SIDS (37.0%), unknown cause of death (34.7%), and accidental suffocation and strangulation in bed (28.3%) [8]. The discrepancy between these findings and our results may be due to the difference in investigation method, with the present SUDI cases all being autopsied. The difference in lifestyle may also have had an effect, with sleeping together in the bed with the mother for breastfeeding being common in Japan. In future work, to confirm the present results, it will be necessary to accumulate SUDI cases with the correct cause of death.

This study has clarified all causes of death in a Japanese prefecture over 3 years. To the best of our knowledge, no previous study has examined the cause of death for children by combining death certificates and forensic autopsy results in Japan. The results also revealed the preventable deaths and suggested further measures that could prevent such deaths. These efforts might be useful for preventing child deaths and promoting Child Death Review.

According to Table 2, the cause of all unnatural deaths in infants was suffocation. In 4 of 7 of these cases, the situations where suffocation occurred were co-sleeping with the mother or breastfeeding. In Japan, co-sleeping (mostly with the mother) is a traditional practice for most infants. Although this close contact has benefits for the infant, it has

substantially contributed to unexpected infant deaths [9]. After the “Back to Sleep” campaign in the UK, the proportion of SUDI cases that had been placed prone for sleeping fell from 89% in 1980 to 24% in 1999–2003; however, that of co-sleeping rose from 12% to 50% over the same period [10]. This alarming rise in prevalence of co-sleeping in case–control studies of SUDI led to a recommendation against co-sleeping, and some countries have already adopted this stance [11-14]. In the UK and Australia, it is recommended that parents be informed about the risks and benefits associated with co-sleeping [10]. The American Academy of Pediatrics published recommendations for safe infant sleeping environments and described bed-sharing situations as unsafe in any circumstances [9]. In addition, the use of a firm sleep surface such as a firm crib mattress covered by a fitted sheet was recommended to reduce the risk of suffocation. Therefore, most fatal suffocation cases that are potentially preventable occur in highly hazardous sleeping environments. Co-sleeping has also been used to encourage breastfeeding. In Japan, mothers are sometimes advised to breastfeed while lying down with their baby to promote breastfeeding. However, if the mother falls asleep during breastfeeding, the infant can easily suffocate because of compression of the mouth or nasal cavity. Although there is no evidence that breastfeeding during co-sleeping increases the risk of SUDI, the present results highlight the risk presented by breastfeeding during co-sleeping and the importance of further preventive activities.

Generally, most unintentional injuries to children younger than 5 years occur in the home. The present cases were in line with this trend. Against this background, home safety intervention programs have been considered to be effective for decreasing injuries suffered in the home [15-17]. These programs educate parents and caregivers who may

not always be aware of potential injury hazards to children in the home. Therefore, healthcare professionals in Japan should provide safe intervention programs for pregnant women attending maternal health check-ups or mothers' classes, especially as Japan's Maternal and Child Health Law stipulates that pregnant women must receive health education through such classes. Injuries among children are associated with high costs to individuals and society in the form of emergency medical care, rehabilitation care, and years of potential life lost, as well as immeasurable emotional costs to their families and loved ones [18]. Effective interventions must be implemented to decrease the number of deaths and long-term disabilities among children.

In the present study, the leading cause of unnatural death was suicide, and all victims were school-aged children. Suicide in children and adolescents has become a social issue in Japan because it is the major cause of death among this demographic group. Although the number of all suicides in Japan decreased from 25,427 in 2014 to 20,169 in 2019, that among those younger than 20 years increased from 536 to 639 [19]. Furthermore, the number of suicides among elementary and high school children in 2019 was the highest. Therefore, the promotion of suicide prevention among school-aged children is a high priority. Many risk factors for suicide have been identified; especially in children, focus has been placed on individual psychological problems, family problems, and school problems [20]. Therefore, to establish effective preventive measures, detailed investigations of the background of each suicide are required. Because such information could not be obtained through the present method, further in-depth investigations with the collection of information from the police, school, and family members are required.

This study also examined the broader characteristics of natural deaths. Deaths due to perinatal abnormalities were common in neonates and those due to congenital diseases were common in infants. Furthermore, deaths related to acute and chronic diseases were most frequent in toddlers and deaths due to malignant diseases and suicide were most frequent in school-aged children. This information may be useful for promoting CDR in Japan. However, because detailed clinical data were not obtained in the present study, the authors could not verify whether the patient had transferred to an appropriate medical facility, been diagnosed correctly and in a timely manner, or undergone adequate medical intervention. Upon increasing the range of information sources, further analyses might be required to consider additional preventive measures.

According to the revised Manual for Model Project for CDR published by MHLW, parental consent was required. The trends of child deaths and the circumstances of accidental deaths in cases in which parental consent was not obtained in Shiga, Japan, were clarified by the method presented here. This information may be valuable for decreasing preventable accidental deaths. However, the results of detailed investigations, such as on prehospital care, progression of any disease, circumstances of death, and manner of suicide, were lacking. Therefore, it would be difficult to propose a method of promoting suicide prevention or disease prevention based on the manual for the Model Project for CDR by MHLW. As the detailed methods and procedures for CDR have not been officially implemented at the governmental level in Japan, legislation enshrining into law the right to collect detailed information about child deaths without parental consent is indispensable for performing optimal CDR. **In other countries where CDR has been conducted, it has been performed under specific legislation [21]. For example, in**

the procedures regarding CDR in the UK and Australia, consent of the next of kin is not mandated under The Children's Act in the UK and the Children and Community Services Act 2004 in Australia. In the USA, CDR is performed in all states under federal regulations [22]. Although these regulations do not require consent of the next of kin, state-level regulations vary, and in some states, consent of the next of kin needs to be obtained. On the other hand, in the Netherlands, a pilot study on the implementation of CDR was performed, for which written informed consent of the parents was required [23]. Therefore, for CDR, there is inconsistency in the requirement of consent of the victims' next of kin among countries or states.

This study had some limitations. First, there were some errors in the information on the death certificates, including inadequate descriptions of the disease or injury and inaccurate classifications of the manner of death. Therefore, in six cases, the cause of death was classified as "unknown." However, some of the present authors were forensic pathologists and could correct the inadequate descriptions, and in most cases there was sufficient information for analysis. Second, because the present method was based on death certificates submitted to the prefecture, the sample differed from previous hospital-based samples. In Japan, a death certificate must be submitted to the municipality where the decedent had been living. Therefore, if a patient living outside Shiga Prefecture had died within the prefecture, the decedent was not included in this study. However, decedents living in Shiga Prefecture who had died outside of this area were included. These differences should be considered when comparing the results of CDR with different procedures.

Conclusions

We performed a review of deaths of children in Shiga Prefecture by combining information from death certificates and forensic autopsies. The prevalence of each cause of death differed significantly by age group. Suicide was the leading cause of unnatural death and most common in school-aged children, followed by suffocation, which was most common in infants. The situations reported for suffocation were co-sleeping with the mother or breastfeeding. Because most fatal suffocation cases are potentially preventable and occur in highly hazardous sleeping environments, safe intervention programs are required for parents or caregivers. These findings were obtained by death review without parental consent and provided basic information for implementing detailed methods and procedures for CDR at the governmental level. To perform optimal CDR, legislation enshrining into law the right to collect detailed information about child deaths without parental consent is required.

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Disclosure

Conflicts of Interest: The authors declare that there are no conflicts of interest.

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Institutional Review Board Statement: This study was conducted following approval from the Ethical Committee of Shiga University of Medical Science (R2020-164).

Author Contributions: E.I. conceptualized the study, performed the survey, collected and analyzed the data, and drafted the manuscript. M.H. designed the methodology, collected and analyzed the data, and drafted the manuscript; Y.M. supervised the study and performed critical review, and edited and finalized the manuscript. M.N. collected and analyzed the data. M.T. collected the data and edited the manuscript. A.M. analyzed the data and made a figure and tables. M.B. performed statistical analyses and edited the manuscript. All authors have read and agreed to the submitted version of the manuscript.

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Figure 1. Age distribution of the 131 cases of child death among residents of Shiga Prefecture (Japan) in 2015–2017.

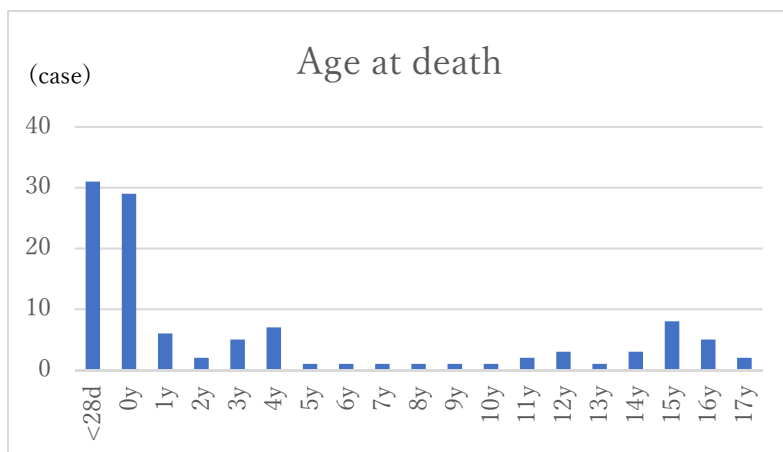


Table 1. Comparisons among age groups by cause of death.

	total		Neonate(<1m)		Infant(<1y)		Toddler(1-5y)		Shool aged child(6y-17y)		p-value
		(%)		(%)		(%)		(%)		(%)	
Natural death	95	72.5	32	24.4	26	19.8	20	15.3	17	13.0	
Infection	9	6.9	0	0.0 ^{††}	4	3.1	4	3.1	1	0.8	0.1
Acute disease	8	6.1	0	0.0 ^{††}	2	1.5	5	3.8 [†]	1	0.8	0.0
Chronic disease	7	5.3	0	0.0 ^{††}	0	0.0	3	2.3	4	3.1 [†]	0.0
Malignant disease	19	14.5	3	2.3	3	2.3	3	2.3	10	7.6 [†]	<0.001
*Perinatal disease	20	15.3	20	15.3 [†]	0	0.0	0	0.0	0	0.0	<0.001
Congenital disease	32	24.4	9	6.9	17	13.0 [†]	5	3.8	1	0.8 ^{††}	0.0
Unnatural death	30	22.9	3	2.3	5	3.8	6	4.6	16	12.2	
Homicide	4	3.1	2	1.5 [†]	0	0.0	1	0.8	1	0.8	0.0
Suicide	10	7.6	0	0.0	0	0.0	0	0.0	10	7.6 [†]	0.0
Traffic accident	4	3.1	0	0.0	0	0.0	1	0.8	3	2.3	0.6
Drowning	3	2.3	0	0.0	0	0.0	2	1.5	1	0.8	0.2
Suffocation	7	5.3	1	0.8	5	3.8 [†]	1	0.8	0	0.0 ^{††}	<0.001
Fire victim	1	0.8	0	0.0	0	0.0	1	0.8	0	0.0	0.2
Other	1	0.8	0	0.0	0	0.0	0	0.0	1	0.8	0.8
Undetermind(unknown/SIDS)	6	4.6	1	0.8	3	2.3	0	0.0	2	1.5	0.3
*Perinatal disease: Deaths from sequelae associated with perinatal events, regardless of age at death											
†The adjusted residual value was significantly higher than expected frequency.											
††The adjusted residual value was significantly lower than expected frequency.											

Table 2. Background of the decedents and situations of accidental deaths.

Age	Sex	Autopsy	Cause of death	Time of occurrence	Situation
0M	F	+	Suffocation	pm.10:00	Breast feeding and co-sleeping with mother. The face was contacted with mother's body.
1M	F	+	Suffocation	am.5:00	Co-sleeping with mother. Face down and covered with a blanket.
4M	M	+	Suffocation	am.3:00	Co-sleeping with parents and 5 sisters. The face was covered with blanket.
5M	F	+	Suffocation	am.0:00	Sleeping on the bed. The face was covered with a quilt.
7M	F	+	Suffocation	am.4:00	Co-sleeping with parents and a sister. The face was covered with blanket.
10M	M	+	Suffocation	pm.3:00	Sleeping on a large bed. The face was covered with pillow and quilts on the bed.
1Y11M	M	+	Suffocation	pm.1:15	Sleeping face down at child care facility.
1Y1M	M	-	Drowning	am.10:00	Falling into water tank.
3Y0M	M	-	Drowning	unknown	unknown
16Y5M	M	-	Drowning	pm.1:30	Accidentally drowning while playing in the lake.
2Y4M	M	-	Motor vehicle	pm.4:30	While walking, collided by a motor vehicle.
15Y2M	M	-	Motor vehicle	pm.8:30	While walking collided by a motor vehicle.
16Y11M	M	-	Motor vehicle	am.0:05	While driving a motorcycle, collided to a guardrail under the influence of alcohol.
17Y2M	M	-	Motor vehicle	pm.6:50	While crossing a road, collided by a motor vehicle.
5Y8M	M	+	Burning	am.1:00	The home was fired while sleeping.