

Brief Report

Survival Factors Associated with Toilet-Related Out-of-Hospital Cardiac Arrest

Yoshio Tanaka ^{1,2,3,*}, Takahisa Kamikura ⁴, Hitoshi Owada ⁴ and Hideo Inaba ^{3,5,*}

¹ Department of Emergency and Disaster Medicine, Graduate School of Medical Sciences, Kanazawa University, 13-1 Takara-machi, Kanazawa 920-8641, Japan

² Department of Surgery, Shin Kyoto-Minami Hospital, 94 Shichijo Goshonouchikita-machi, Shimogyo-ku, Kyoto 600-8861, Japan

³ Department of Emergency Medicine, Kanazawa Medical University, 1-1 Daigaku, Uchinada-machi, Kahoku-gun, Ishikawa 920-0293, Japan

⁴ Department of Emergency Medical Science, Faculty of Health Science, Suzuka University of Medical Science, 3500-3, Minamitamagaki, Suzuka 513-8670, Japan

⁵ Department of Emergency Medical Sciences, Niigata University of Health and Welfare, 1398 Shimami-cho, Kita-ku, Niigata 950-3198, Japan

* Correspondence: ytanaka.md@gmail.com (Y.T.); hideo-inaba@nuhw.ac.jp (H.I.);

Tel.: +81-76-265-2000 (Y.T.); +81-25-257-4455 (H.I.); Fax: +81-76-234-0973 (Y.T.); +81-25-257-4456 (H.I.)

Abstract: Objective: To identify the factors associated with a neurologically favourable survival of out-of-hospital cardiac arrest (OHCA) occurring in toilets. **Methods:** We retrospectively compared neurologically favourable 1-month survival rates and survival-related factors for 330,849 non-emergency medical service-witnessed OHCA that occurred in toilets with those that occurred elsewhere using a nationwide database. **Results:** Compared to outpatient or hospital admission, OHCA was more likely to be associated with toilets (crude odds ratio [cOR] [95% confidence interval [CI]]: 2.52 [2.48–2.57]). The neurologically favourable 1-month survival rate for OHCA occurring in toilets (1.8%) was significantly lower than that in other places (2.9%) (cOR [95% CI]: 0.60 [0.53–0.68]). Bystander cardiopulmonary resuscitation (CPR) and automated external defibrillator (AED) use were minimal in toilets. Neither bystander CPR (adjusted OR [95% CI]: 1.19 [0.91–1.75]) nor AED use (adjusted OR [95% CI]: 2.05 [0.65–6.41]) was associated with improved neurologically favourable 1-month survival in toilets. **Conclusions:** Despite the poor neurologically favourable survival rate of OHCA in toilets, the provision of bystander CPR and AED was not associated with survival. Potential contributing factors include low rates of bystander intervention and delayed patient detection. To address this issue, focusing particular attention on unwell patients who use the toilets is crucial, and preventive approaches should be promoted.

Keywords: out-of-hospital cardiac arrest; bystander action; survival; toilets; strategy



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1. Introduction

To improve survival rates in out-of-hospital cardiac arrest (OHCA), which has a poor outcome to date, it is crucial to direct attention to the locations where these events transpire. A comprehensive assessment of patient characteristics at the location of the OHCA occurrences provides valuable insights. These findings can be employed to devise more effective strategies, including widespread education of laypersons.

Certain daily human activities are associated with OHCA. Bathing [1] and visiting toilet facilities are representative activities. In particular, toilets are considered a unique place where cardiac arrest is likely to occur because people use them not only for urination/defecation purposes but also when they feel unwell prior to a cardiac arrest. In addition, the detection of OHCA is delayed because toilets are typically enclosed, restricted spaces that provide maximum privacy. Therefore, the outcome for OHCA in toilets is expected to be poor. Except in studio apartments, household toilets and bathrooms are

generally separated in Japan, making them suitable for evaluating OHCA in the toilets except when patients are bathing.

The previous two small-scale retrospective studies of OHCA in toilets have reported poor outcomes [2,3]. However, factors associated with surviving OHCA in the toilet and other detailed patient characteristics are unknown. Therefore, although a toilet is one of the most familiar places in a person's daily life, little is known regarding the actual status of OHCA that occurs in toilets. Elucidating such an association could help develop more effective strategies to improve survival after OHCA.

Herein, we aimed to identify factors associated with a neurologically favourable 1-month survival of OHCA occurring in the toilet using a national Japanese database, which contains information on all patients with medical emergencies, including OHCA.

2. Materials and Methods

2.1. Study Population and Setting

In this nationwide observational study, we matched transport data from 23,472,547 all-Japan emergency medical service (EMS)-transported cases, including information on detailed characteristics and location and time records of patients registered from 1 January 2016 to 31 December 2019 who were not affected by the coronavirus disease 2019 pandemic, with data from 504,561 all-Japan OHCA cases based on standardised Utstein forms [4]. In Japan, ambulance transportation is free of charge, and emergency medical technicians (EMTs) are not allowed to terminate resuscitation and transportation in the field unless an OHCA patient shows noticeable post-mortem changes. After excluding 39,463 cases of failed case matching, 4,307,440 cases of missing location data, including toilets, 5,466,213 non-medical (trauma) cases, and 13,298,604 non-OHCA cases, 360,827 OHCA cases were included in the final analysis. Of these, 4.1% (14,975) of OHCA occurred in the toilet. In addition, 1.9% (253,942) of all 13,659,431 emergency transports pertained to patients experiencing OHCA in toilets. The results revealed a high incidence of OHCA in all emergency patients transported from toilets (crude odds ratio [cOR] [95% confidence interval [CI]]: 2.52 [2.48–2.57]). Finally, we excluded 29,978 EMS-witnessed cardiac arrest cases because their characteristics and outcomes differed [5,6] and analysed the outcomes of 330,849 non-EMS-witnessed OHCA cases, with 4.2% (13,881) of these occurring in toilets.

2.2. Statistical Analysis

We calculated the cORs and 95% CIs using univariate analysis for significant variables. Multivariable logistic regression analysis was also used to examine whether factors associated with neurologically favourable 1-month survival (defined as Cerebral Performance Category 1–2 [7]) differ between OHCA in toilets and OHCA in other places. The other places were defined as places other than toilets in the home and places other than public toilets outside the home. *p*-values for subgroup interactions were calculated using multivariable interaction tests. In the multivariable analysis model, variables known to be potentially associated with outcomes of OHCA [5,6,8] were added: age, sex, witness status with bystander classification (unwitnessed or witnessed by family, friend/colleague, others), arrest location (home or public locations), place of occurrence (toilets or other places), aetiology (presumed cardiac or not), prehospital initial electrocardiogram (ECG) rhythm (shockable or not), provision of bystander cardiopulmonary resuscitation (CPR), provision of public-access defibrillation (PAD), and time interval from call dispatch to arrival at patients (EMS response time).

All statistical analyses were performed using JMP ver. 17.0 (SAS Institute, Cary, NC, USA). The null hypothesis was evaluated for each analysis with a two-sided significance level of $p < 0.05$, with 95% CIs calculated using the profile likelihood.

3. Result

The incidence of OHCA in toilet rooms was higher among older people and during night-time and lower among children and during winter. Bystander-witnessed cases (cOR

[95% CI]: 1.09 [1.02–1.16]) and unwitnessed cases (cOR [95% CI]: 1.20 [1.12–1.27]) were predominantly higher than EMS-witnessed cases. The proportion of initial shock-adapted ECG rhythm was lower (2.8% in the toilets vs. 4.8% in other places); however, the aetiology (cardiac and non-cardiac) did not significantly differ. Compared with OHCA in toilets at home, OHCA in public toilets was more likely to occur during the day, with fewer older adult patients, and was more frequently unwitnessed (Table 1).

For non-EMS-witnessed OHCA cases, the bystander CPR rates (cOR [95% CI]: 0.44 [0.43–0.46]) and PAD rates (cOR [95% CI]: 0.12 [0.08–0.17]) were lower in OHCA in toilets than in other places (Supplemental Table S1). The witness was predominantly a family member, and the incidence was also associated with toilets (5.6%; cOR [95% CI]: 1.32 [1.27–1.37]). In addition, bystander CPR was less frequent in OHCA in public toilets than in OHCA in home toilets (0.5% vs. 4.0%).

The rates of neurologically favourable 1-month survival (1.8% [243/13,881] in toilets vs. 2.9% [9166/316,968] in other places, cOR [95% CI]: 0.60 [0.53–0.68]) were significantly lower in toilets compared with those in other places. In addition, this survival rate was significantly lower at home (1.7% [224/13,310] in toilets vs. 2.0% in other places [4626/231,297], cOR [95% CI]: 0.84 [0.74–0.96]) than in public (3.3% [19/571] in toilets vs. 5.3% [4540/85,671] in other places, cOR [95% CI]: 0.61 [0.39–0.97]) (Figure 1).

Comparison of survival rate in OHCA occurring in toilets and other places

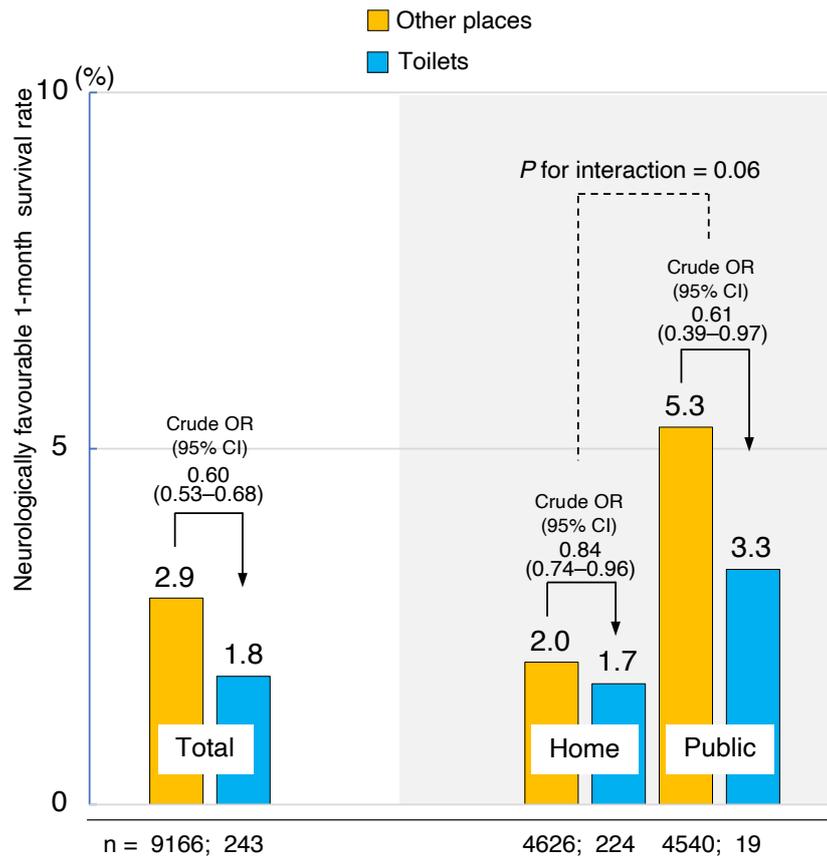


Figure 1. Comparison of neurologically favourable 1-month survival in OHCA occurring in toilets and other places. OR (95% CI) is determined via univariate analysis. The *p*-value for the interaction of subgroups among home and public locations (shown by a dotted line) is calculated using a univariate interaction test. Abbreviations: OR, odds ratio; 95% CI, 95% confidence interval.

Table 1. Characteristics of all patients with OHCA in home and in public toilets.

Characteristics	All EMS-Transported OHCA			Location						<i>p</i> for Interaction among Home and Public Locations
	Total N = 360,827	In Toilets % (N) 4.2% (14,975)	Crude OR (95% CI)	Total N = 268,071 (72.3%)	In Toilets % (N) 5.4% (14,372)	Crude OR (95% CI)	Total N = 92,756 (25.7%)	In Toilets % (N) 0.7% (603)	Crude OR (95% CI)	
	Sex									<i>p</i> < 0.001
Male	200,111	4.8% (9561)	1.44 (1.39–1.49)	155,981	5.9% (9183)	1.29 (1.24–1.33)	44,130	0.9% (378)	1.86 (1.57–2.19)	
Female	160,716	3.4% (5414)	(Reference)	41.8% 112,090	4.6% (5189)	(Reference)	52.4% 48,626	0.5% (225)	(Reference)	
	Age group									<i>p</i> < 0.001
Child (<18 y)	3237	2.1% (67)	0.41 (0.32–0.52)	2939	2.3% (67)	0.38 (0.29–0.48)	298	0% 0	Not available	
Adult (≥18 y, <65 y)	49,788	4.9% (2441)	(Reference)	37,955	5.8% (2213)	(Reference)	11,833	1.9% (228)	(Reference)	
Older adult (≥65 y)	307,802	4.1% (12,467)	1.22 (1.17–1.28)	227,177	5.3% (12,092)	0.91 (0.87–0.95)	80,625	0.5% (375)	0.24 (0.20–0.28)	
	Seasons									<i>p</i> = 0.19
Spring	87,481	4.1% (3562)	1.01 (0.97–1.06)	64,487	5.3% (3413)	1.06 (1.01–1.11)	22,994	0.7% (149)	0.97 (0.78–1.21)	
Summer	70,066	4.3% (2987)	1.06 (1.01–1.11)	50,414	5.7% (2871)	1.14 (1.09–1.20)	19,652	0.6% (116)	0.89 (0.70–1.12)	
Autumn	82,055	4.3% (3542)	1.07 (1.03–1.12)	59,450	5.7% (3387)	1.14 (1.09–1.20)	22,605	0.7% (155)	1.03 (0.83–1.28)	
Winter	121,225	4.0% (4884)	(Reference)	93,720	5.0% (4701)	(Reference)	27,505	0.7% (183)	(Reference)	
	Time of day									<i>p</i> < 0.001
Daytime (8:00–20:00)	203,785	4.0% (8137)	0.91 (0.88–0.94)	149,384	5.2% (7696)	0.91 (0.88–0.94)	54,401	0.8% (441)	1.93 (1.61–2.31)	
Night-time (20:01–7:59)	43.5% 157,042	4.4% (6838)	(Reference)	44.3% 118,687	5.6% (6676)	(Reference)	41.4% 38,355	0.4% (162)	(Reference)	

Table 1. Cont.

Characteristics	All EMS-Transported OHCA			Location						<i>p</i> for Interaction among Home and Public Locations
	Total N = 360,827	In Toilets % (N) 4.2% (14,975)	Crude OR (95% CI)	Total N = 268,071 (72.3%)	In Toilets % (N) 5.4% (14,372)	Crude OR (95% CI)	Total N = 92,756 (25.7%)	In Toilets % (N) 0.7% (603)	Crude OR (95% CI)	
Witness status										<i>p</i> < 0.001
Bystander-witnessed	117,787	4.0% (4655)	1.09 (1.02–1.16)	81,056	5.6% (4506)	1.24 (1.16–1.33)	36,731	0.4% (149)	0.83 (0.56–1.21)	
EMS-witnessed	29,978	3.7% (1094)	(Reference)	23,464	4.5% (1062)	(Reference)	6514	0.5% (32)	(Reference)	
Unwitnessed	213,062	4.3% (9226)	1.20 (1.12–1.27)	163,551	5.4% (8804)	1.20 (1.12–1.28)	49,511	6.5% (422)	1.74 (1.21–2.50)	
Aetiology										<i>p</i> = 0.85
Presumed cardiac	263,923	4.1% (10,874)	0.97 (0.94–1.01)	194,540	5.4% (10,426)	1.00 (0.96–1.04)	74.8% 69,383	0.7% (448)	0.97 (0.81–1.18)	
Non-cardiac	96,904	4.2% (4101)	(Reference)	27.4% 73,531	5.4% (3946)	(Reference)	25.2% 23,373	0.7% (155)	(Reference)	
Initial ECG rhythm										<i>p</i> < 0.001
Shockable	27,570	2.8% (773)	0.65 (0.60–0.70)	16,572	4.3% (706)	0.78 (0.71–0.83)	10,998	0.6% (67)	0.93 (0.72–1.20)	
Non-shockable	333,257	4.3% (14,202)	(Reference)	93.8% 251,499	5.4% (13,666)	(Reference)	88.1% 81,758	0.7% (536)	(Reference)	
Defibrillation by EMS										<i>p</i> = 0.22
Performed	39,495	3.4% (1360)	0.81 (0.76–0.85)	26,123	4.9% (1269)	0.89 (0.84–0.94)	13,372	0.7% (91)	0.95 (0.76–1.18)	
Not performed	321,332	4.2% (13,615)	(Reference)	90.3% 241,948	5.4% (13,103)	(Reference)	85.6% 79,384	0.6% (512)	(Reference)	

Abbreviations: EMS, emergency medical service; OHCA, out-of-hospital cardiac arrest; ECG, electrocardiogram. The crude odds ratios (cORs) and 95% confidence intervals (CIs) are calculated using univariate analysis for significant variables. The *p*-value for the interaction of toilet room subgroups among home and public locations is calculated using a multivariate interaction test. Bold font indicates statistical significance.

Multiple logistic regression analysis of the factors associated with neurologically favourable 1-month survival showed that age <18 years was significantly associated with improved neurologic outcomes for both OHCA in toilets and other spaces. Among patients with OHCA at home, those with OHCA in toilets had worse neurological outcomes than those with OHCA in other places. For patients with OHCA in toilets, those who had family-witnessed OHCA had better neurological outcomes than those with non-witnessed OHCA (adjusted odds ratio [aOR] [95% CI]: 3.41 [2.54–4.58]). However, OHCA witnessed by friends/colleagues had no association with outcomes (aOR [95% CI]: 1.52 [0.43–5.31]). For toilet room OHCA, PAD provision was significantly associated with better neurological survival, while presumed cardiac aetiology was associated with poorer survival. Notably, the provision of bystander CPR and PAD for OHCA in other places was associated with better neurological survival (aOR [95% CI]: 1.61 [1.53–1.70] and 1.63 [1.50–1.77], respectively) but not for OHCA in toilets (aOR [95% CI]: 1.19 [0.91–1.57] and 2.05 [0.65–6.41], respectively) (Figure 2).

Comparison of factors associated with survival in OHCA occurring in toilets and other places

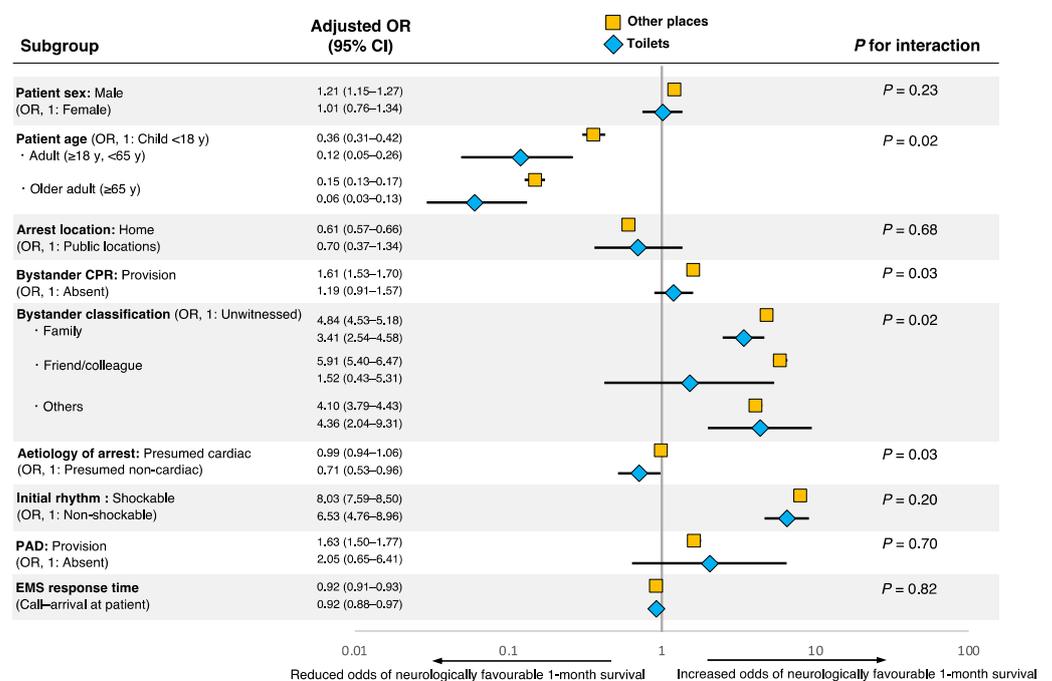


Figure 2. Comparison of factors associated with neurologically favourable 1-month survival in OHCA occurring in toilets and other places. The adjusted results are presented using a comprehensive multiple logistic regression analysis. This approach examines whether the factors mentioned in the main text associated with neurologically favourable 1-month survival exhibit differences between OHCA in toilets and other places. The *p*-value for subgroup interaction between toilets and other places is calculated using a multivariable interaction test. Abbreviations: CPR, cardiopulmonary resuscitation; PAD, public-access defibrillation; EMS, emergency medical service; OR, odds ratio; 95% CI, 95% confidence interval.

4. Discussion

The current study observed that the incidence of OHCA in the toilet is higher than in patients with other minor illnesses, with 4.1% of cardiac arrest cases occurring in toilets. In addition, cardiac arrests were more likely to occur in toilets than in other places, considering the amount of time spent in these rooms (approximately 20 min per day [1.4%/day]) [9]. The likelihood of experiencing cardiac arrest was 7.7 times higher in home toilets than in public toilets.

Family member-witnessed OHCA, but not friend/colleague-witnessed OHCA, had a higher likelihood of favourable neurological survival. Previous studies have demonstrated that OHCA cases witnessed by friends/colleagues have better outcomes than cases witnessed by family members in the context of psychological effects and other factors [10]. Since toilets are private spaces, friends/colleagues are more likely to hesitate to call out or knock on the door than family members, and this may contribute to the lack of improvement in friend/colleague-witnessed OHCA outcomes. Notably, our study also found that providing bystander CPR and PAD, significant prognostic factors for cardiac arrest patients [5,6], were not associated with improved outcomes for OHCA in toilets. One of the causes was that provision rates of both bystander CPR and PAD were very low in toilets. We speculate that toilets are very confined spaces, which limit the space for resuscitation efforts, and that it may be difficult to reposition patients into the supine position, since they are sometimes found seated on a toilet seat. In addition, this particular situation may prolong the time of EMS field activities, resulting in a poor outcome [11]. Therefore, we consider that resuscitation education methods for OHCA in toilets should incorporate strategies for specific situations in which cardiac arrest occurs in the toilets, including how to rescue patients from the toilets.

Another possible contributing factor could be that although there was no difference in the EMS response time between emergencies in toilets and other places, the time from patient collapse to call (finding) might be longer for OHCA occurring in toilets. Thus, the crucial time when bystander CPR and PAD are effective immediately after collapse may be missed. Therefore, to improve the outcome of OHCA in toilets, it is essential to recognise a patient in distress as soon as possible. It is necessary to educate the public that (1) if a person with a history of syncope or who is not feeling well uses the toilet, they should inform those around them before using it, and (2) it is vital to make an early emergency call before entering the toilet, especially when realising that someone in poor health is unwell or has a sudden onset of symptoms such as chest pain.

Preventive approaches are also critical when there is no one around. It is essential to install an intelligent home emergency notification system that automatically detects collapses, especially in home toilets, and the emergency dispatcher or security company is automatically notified. It would also be critical to install automated external defibrillators (AEDs) at the entrance to public toilets, in addition to requiring the installation of emergency buzzers. Smartwatches that automatically detect and report falls would also be effective, especially for older adults.

Our study has some limitations. First, this was an observational study, and unmeasured confounding factors or trends may explain outcome differences. Second, the combining/reconciling process of the two databases failed to include 0.17% of case failures, and 0.76% of cases had missing location information. The exclusion of these patients may have affected the outcomes. Nonetheless, this study included a notably large retrospective cohort, and the results will help develop new strategies to manage OHCA occurring in toilets.

5. Conclusions

Although the neurologically favourable survival rate of OHCA in toilets is poor, the provision of bystander CPR and PAD was not associated with that outcome. Possible causes include low provisioning rates and delayed patient detection. In addition to paying particular attention to unwell patients who use the toilets, preventive approaches, such as early emergency calls and the installation of systems that automatically detect collapses, should be promoted.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/ecm1020009/s1>, Table S1: Characteristics of the non-EMS-witnessed patients with OHCA in home and in public in toilets.

Author Contributions: Y.T. and H.I. take responsibility for the paper as a whole. Y.T. and H.I.: Conceptualisation and Validation; Y.T. and H.I.: Data curation; H.I.: Formal analysis; Y.T.: Writing—original draft preparation; Y.T., T.K., H.O. and H.I.: Supervision and Validation; Y.T. and H.I.: Project administration. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement: Patient consent was waived because of retrospective data collected without personal identifying information.

Data Availability Statement: Restrictions apply to the availability of these data. These data were obtained from the Fire and Disaster Management Agency (FDMA) in Japan.

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Conflicts of Interest: The authors declare no conflict of interest.

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