



Brief Communication

Out-of-hospital cardiac arrests in the toilet in Japan: a population-based descriptive study

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Aim: This study aimed to reveal the characteristics and outcomes of patients with out-of-hospital cardiac arrests (OHCAs) occurring in the toilet. These traits provide useful clues for the prevention of OHCAs and the improvement of prehospital care for these patients.

Methods: Out-of-hospital cardiac arrest data were obtained from the population-based, Utstein-style registry in Osaka City, Japan, between 2009 and 2015. This study identified patients with OHCAs that occurred inside the toilet. The primary end-point was 1-month survival with favorable neurological outcome after OHCA.

Results: During the 7-year study period, a total of 18,458 OHCAs were identified. Of these cases, 849 (4.6%) occurred inside the toilet. Among them, the analysis included 733 patients. The distribution depicting monthly OHCA occurrences showed that OHCAs tended to occur in cold months (28.1% [206/733] from October to December and 30.0% [220/733] from January to March). Most OHCAs occurring inside the toilet were of cardiac origin (91.5% [671/733]), and 36.2% (265/733) were witnessed by bystanders. The proportion of patients with ventricular fibrillation was 5.2% (38/733) and those receiving shocks by public-access automated external defibrillators was 0.4% (3/733). The proportion of patients with 1-month survival with favorable neurological outcome was 1.9% (14/733).

Conclusions: Out-of-hospital cardiac arrests occurring inside the toilet accounted for 4.6% of all OHCAs and were frequently observed during cold months, and their outcome was poor. Establishment of preventive measures against OHCAs occurring in the toilet as well as earlier recognition of OHCAs are needed.

Key words: Epidemiology, outcome, out-of-hospital cardiac arrest, population, toilet

INTRODUCTION

DEFECATION AND MICTURITION are common activities performed by human beings and might trigger cardiac arrest.^{1,2} As the toilet is usually a closed space, it is difficult to quickly detect the patients with cardiac arrest occurring inside the toilet. A retrospective study from a single center indicated that approximately 10% of patients with out-of-hospital cardiac arrest (OHCA) were found in the toilet, but their prognosis was poor because of the delay in discovering the collapsed victims.² Thus, OHCA occurring in the

toilet is unique in terms of resuscitation science. However, in comparison to OHCA occurring during other situations such as bathing,³ exercising,⁴ and driving,⁵ the epidemiology of emergency patients with OHCAs occurring inside the toilet has not been sufficiently investigated at the population level. Considering that OHCAs commonly occur in the toilet in community settings,² further study is needed to grasp the present situation and provide some clues for prevention and improvement of prehospital care. Using a population-based registry of OHCAs, this study aimed to reveal the characteristics and outcomes of patients to provide useful clues for the prevention of OHCAs and the improvement of prehospital care of patients with OHCAs occurring inside the toilet.

METHODS

Study design, settings, and patients

THE DETAILS OF the OHCA registry and emergency medical service (EMS) system in Osaka City, which is

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the largest metropolis in western Japan and has a population of approximately 2.7 million in an area of 222 km², have been previously described.³ The Osaka Municipal Fire Department registered the ambulance records of Osaka City and linked them to the data on resuscitation that was simultaneously collected in accordance with the Utstein-style guidelines.^{3,6} Cardiac arrest was considered to be of presumed cardiac origin unless it was caused by cerebrovascular disease, aortic disease and pulmonary embolism, respiratory disease, malignant tumor, external origins such as trauma including traffic injury, drowning, drug overdose, and asphyxia, or any other non-cardiac origin. These diagnoses were made clinically by the physician caring for the patient, in collaboration with EMS personnel. The target group of this study was patients with OHCA occurring inside the toilet.

Data collection and statistical analysis

This study enrolled patients who experienced an OHCA and were then transported to a medical institution by EMS personnel from January 2009 to December 2015. Data were collected using information from a form that included the fields recommended by the Utstein-style reporting guidelines for cardiac arrests.⁶ These data included date, sex, age, first documented cardiac rhythm, witness status, location of arrest, activities of daily living before arrest, a series of EMS time stamps, bystander-initiated cardiopulmonary resuscitation (CPR), public-access automated external defibrillation (AED) use, dispatcher instruction, intravascular fluid, administration of adrenaline, advanced airway management, as well as the outcome measures of prehospital return of spontaneous circulation, 1-month survival, and neurological status 1 month after the event. Neurological outcomes were determined by the physician responsible for treating the patient using the cerebral performance category scale: category 1, good cerebral performance; category 2, moderate cerebral disability; category 3, severe cerebral disability; category 4, coma or vegetative state; and category 5, death. Favorable neurological outcome was defined as cerebral performance category 1 or 2.⁶

Out-of-hospital cardiac arrest cases involving attempted resuscitation by EMS personnel or bystanders were included in the analysis. Those witnessed by EMS personnel, traumatic causes (such as suicide), or those with missing values were excluded from analyses. The patient characteristics, prehospital care, and outcomes after OHCA occurring inside the toilet were described. The number of occurrences of OHCA was counted, by month, based on the location of arrest, including home toilets, public toilets, and toilets in health-care facilities. All statistical analyses were undertaken

using the SPSS statistical package version 24.0J (IBM, Armonk, NY, USA).

RESULTS

DURING THE 7-year period, a total of 18,458 OHCA cases were registered and, of these, 849 (4.6%) were OHCA occurring inside the toilet (Fig. 1). The incidence rate was 4.5 per 100,000 people per year. This is equivalent to an estimated annual number of 5,800 OHCA occurring inside the toilet in Japan. Patients who were not resuscitated ($n = 16$), those with OHCA caused by trauma ($n = 51$), those with OHCA after EMS arrival ($n = 46$), and those with undocumented outcomes ($n = 3$) were excluded. Analysis was carried out on 733 eligible patients.

The majority of OHCA (82.3%, 603/733) occurred in home toilets and 11.5% (84/733) and 6.3% (46/733) occurred in public toilets and toilets in health-care facilities, respectively. In the monthly distribution indicating the number of OHCA occurrences in the toilet (Fig. 2), OHCA tended to occur in cold months (28.1% [206/733] from October to December and 30.0% [220/733] from January to March).

Table 1 shows patient characteristics, prehospital care, and outcomes after OHCA. Overall, male patients accounted for approximately 61.8% of the sample and the proportion of OHCA with presumed cardiac origin and cerebrovascular disease was 91.5% and 3.0%, respectively. Approximately one-third of OHCA (36.2% [265/733]) were witnessed by bystanders. The proportion of patients with ventricular fibrillation was 5.2% (38/733) and those

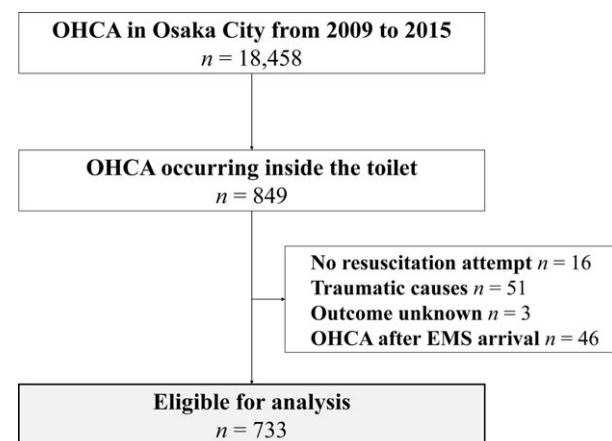


Fig. 1. Selection of cases for inclusion in an analysis of the occurrence of out-of-hospital cardiac arrests (OHCA) in the toilet in Osaka City, Japan, over a 7-year period. EMS, emergency medical service.

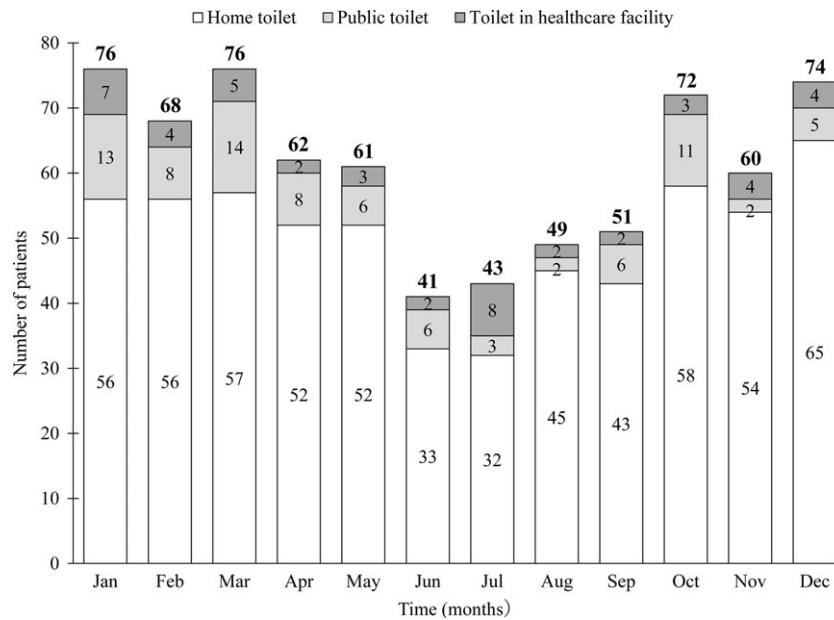


Fig. 2. Monthly distribution of the occurrence of out-of-hospital cardiac arrests in the toilet in Osaka City, Japan, over a 7-year period.

receiving shocks by public-access automated external defibrillators was 0.4% (3/733). Patients with OHCAs occurring inside the toilet had a poor outcome. The proportion of 1-month survival with favorable neurological outcome was only 1.9% (14/733).

DISCUSSION

IN THIS POPULATION -based study, we observed that OHCAs occurring inside the toilet accounted for 4.6% of all OHCAs; among them, the proportion of cases with a favorable neurological outcome was only 1.9%. Unlike OHCAs caused by other daily activities, including sports or bathing,^{3,4} little attention has been paid to OHCAs during toilet activity, even in CPR guidelines.⁷ However, assessing and understanding OHCAs is important for resuscitation researchers because approximately 5,800 OHCAs are estimated to occur inside the toilet throughout Japan every year.

There are some mechanisms that explain the occurrence of OHCAs in the toilet. In defecation and micturition, a person unconsciously holds their breath while straining in the toilet. This Valsalva maneuver might lead to the rapid increase of blood pressure and could result in cardiac arrest due to acute coronary syndrome as well as subarachnoid hemorrhage.² This is particularly true in patients with diabetes mellitus or those with a history of heart disease.² In addition, defecation and micturition cause

syncope and altered/decreased respiratory function.^{8–10} In defecation/micturition syncope, hypotension caused by an imbalance between sympathetic and parasympathetic autonomic function leads to decreased cerebral blood flow or large changes in systemically stressed blood volume.^{8–10} Thus, rapid and large changes in blood pressure or respiratory function might result in the occurrence of OHCAs in the toilet.

This study highlighted the fact that the majority of OHCAs occurring inside the toilet were observed during cold months, which is similar to results seen in bath-related OHCAs.³ However, considering that approximately 50% of bath-related OHCAs occurred during winter,³ the seasonal difference in occurrence of OHCAs in the toilet seemed to be smaller. Low temperature is suggested to increase sympathetic nerve tone and catecholamine release, which increases heart rate, ventricular contractility, vascular resistance, and blood pressure.^{11,12} These effects might be enhanced by large differences between the elevated room temperature and the low ambient temperature during winter. Therefore, warming the toilet or the whole house to reduce temperature differences in cold months might be one countermeasure to prevent OHCAs occurring in the toilet.

Importantly, the proportion of witnessed OHCAs inside the toilet was only 36%. This is because individuals were generally alone in a closed toilet. Therefore, installing a system that can allow contact with people outside the toilet

Table 1. Patient characteristics, prehospital care, and outcomes of out-of-hospital cardiac arrest occurring inside the toilet over a 7-year period ($n = 733$)

	$n = 733$
Location of occurrence of arrest, n (%)	
Home toilet	603 (82.3)
Public toilet	84 (11.5)
Toilet in health-care facility	46 (6.3)
Men, n (%)	453 (61.8)
Age, years; median (IQR)	76 (65–83)
Good activities of daily living before arrest, n (%)	565 (77.1)
History of ischemic heart disease, n (%)	69 (9.4)
Origin of arrest, n (%)	
Cardiac origin	671 (91.5)
Cerebrovascular disease	22 (3.0)
Respiratory disease	5 (0.7)
Malignant tumor	14 (1.9)
Other non-cardiac origin	21 (2.9)
VF as first documented rhythm, n (%)	38 (5.2)
Witnessed by bystander, n (%)	265 (36.2)
Bystander-initiated CPR, n (%)	
Chest compression-only CPR	181 (24.7)
Conventional CPR	65 (8.9)
No CPR	487 (66.4)
Shock using a public-access AED, n (%)	3 (0.4)
Dispatcher instruction, n (%)	302 (41.2)
Intravenous fluid, n (%)	219 (29.9)
Epinephrine, n (%)	110 (15.0)
Advanced airway management, n (%)	590 (80.5)
EMS response time, min; median (IQR)	8 (6–10)
Outcomes, n (%)	
Prehospital ROSC	68 (9.3)
One-month survival	29 (4.0)
CPC 1 or 2	14 (1.9)

AED, automated external defibrillator; CPC, cerebral performance category; CPR, cardiopulmonary resuscitation; EMS, emergency medical service; IQR, interquartile range; ROSC, return of spontaneous circulation; VF, ventricular fibrillation.

would be helpful inside the home of a person with cardiovascular disease who is at high risk for OHCA. However, in this study, information was not obtained on defecation and micturition activities among patients with OHCAs. For this reason, not all patients would have defecated and micturated and some patients may have gone to the toilet because they felt severely ill or nauseous.² Therefore, family members or staff in health-care facilities must pay attention to these patients for earlier recognition of cardiac arrest. In addition, the prognosis of patients with OHCAs occurring inside the

toilet was poor. This could be explained by the very low proportion of strong prognostic factors, such as ventricular fibrillation arrest, initiation of bystander-initiated CPR, and shocks by public-access AEDs. These results were similar to those with bath-related OHCAs.³ To improve the survival rate from OHCAs occurring inside the toilet, disseminating basic life support education, particularly regarding chest compressions, is also needed so that bystanders can start CPR before EMS arrival.^{7,13}

Limitations

There are some limitations of this study. First, information was not obtained on several factors that could have influenced the OHCA occurrence, such as medical history and medication. Second, as our study area was limited to one metropolis in western Japan, the results might not be easily applicable to other areas, especially cold regions. Finally, in this study, the etiology of cardiac arrest was presumed to be cardiac unless evidence suggested non-cardiac causes. Therefore, there is a possibility that the proportion of OHCA caused by non-cardiac origin, including cerebrovascular diseases, would have been somewhat underestimated.

CONCLUSION

OUT-of-hospital cardiac arrests occurring inside the toilet accounted for 4.6% of all OHCAs, occurred more frequently during cold months, and had poor outcomes. The establishment of measures to prevent OHCAs in the toilet, as well as earlier recognition of the occurrence of OHCAs, are needed.

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DISCLOSURE

Approval of the research protocol: The study protocol was approved by the Ethics Committees of Kyoto University (Kyoto, Japan).

Informed consent: Personal identifiers were removed from the database, and the requirement for informed consent from patients was waived.

Registry and the registration no. of the study/trial: N/A.

Animal studies: N/A.

Conflict of Interest: None.

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