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【 ORIGINAL ARTICLE 】

Incidence and Characteristics of Bath-related Accidents

Masaru Suzuki [1,2], Takuro Shimbo [3], Toshiharu Ikaga [4] and Shingo Hori [1]

Abstract:

Objective Bath-related sudden cardiac arrests frequently occur in Japan. This study aimed to describe the actual incidence and characteristics of bath-related accidents, including non-fatal events, and to establish the etiology of bath-related sudden cardiac arrest.

Methods This prospective cross-sectional observational study was conducted in Tokyo Metropolis and Saga and Yamagata Prefectures between October 2012 and March 2013. Emergency personnel enrolled events in this study when they recognized that activation of the emergency medical system was related to bathing. Surveillance cards were delivered and collected from the emergency personnel and attending physicians.

Results In total, 4,593 events were enrolled (1,528 cardiac arrests, 935 survivors in need of help, 1,553 patients with acute illnesses, and 577 patients with injuries) in this study. In the group of survivors in need of help and with acute illness, consciousness disturbance and lethargy without any organic disease were recognized as the main symptoms. Acute coronary syndrome and stroke were infrequently diagnosed. Of the survivors, 30% had a body temperature above 38°C. Their consciousness level significantly correlated with their body temperature. Emergency personnel reported that 79% of sudden cardiac arrests were from victims whose faces were submerged in the tub water, while 18% of survivors had their faces submerged in the tub water.

Conclusion This study revealed that accidents, including non-lethal events, frequently occur. The key symptoms were consciousness disturbance and lethargy characterized as a functional disorder and accompanied by an elevated body temperature. Those findings suggest that heat illness during hot water immersion causes drowning.

Key words: heat illness, drowning, bath, sudden death, hot water immersion

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Introduction

In an aging society, the burden of life-threatening conditions is increased. Sudden death during bathing frequently occurs in Japan (1, 2). Such bath-related deaths have been reported as accounting for more than 10% of all sudden deaths (1), and most victims are ≥65 years of age (2). We recently reported that the annual nationwide number of bath-related deaths is estimated to be approximately 19,000 (2).

The etiology of such fatal events has never been elucidated. All of the studies investigating bath-related accidents only considered sudden deaths (1, 3-10). Most cases of sudden death have been found in tubs without any traumatic injuries (2). Unfortunately, previous medicolegal investigations have not established the cause for such phenomena (1, 3, 10). Therefore, to elucidate the cause of death, non-fatal events related to bathing were investigated and determined to play a crucial role. It is necessary to study data regarding not only bath-related deaths but also survivors of such accidents.

The present study aimed to investigate the actual incidence and characteristics of bath-related accidents.

[1]Department of Emergency and Critical Care Medicine, Keio University School of Medicine, Japan, [2]Department of Emergency and Internal Medicine, Tokyo Dental College Ichikawa General Hospital, Japan, [3]Ohta Nishinouchi Hospital, Japan and [4]Faculty of Science and Technology, Keio University, Japan

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Correspondence to Dr. Masaru Suzuki, suzuki@tokyo.so-net.jp

Materials and Methods

Surveillance

This prospective cross-sectional observational study was approved by the Ethics Committee of Keio University (#2012-0231). The design has already been described elsewhere (2, 11). In brief, it was conducted between October 2012 and March 2013 in three areas, including the Tokyo Metropolis, Saga Prefecture (Kyushu region, western Japan) and Yamagata Prefecture (along Sea of Japan in Tohoku region). We investigated the data from all occurrences in these areas for which the emergency medical system was activated because of an accident or acute illness related to bathing.

The bath-related events were classified into four categories: 1. Cardiac arrest; 2. A survivor in need of help because of difficulties getting out of a bathtub; 3. Any acute illness; and 4. Injuries. Ambulances are generally called because of injuries or acute illnesses. When an ambulance call is related to bathing, needing help getting out of a bathtub or a bathroom is frequently observed. In this study, such events were defined as a survivor in need of help because of difficulties.

Emergency personnel completed a surveillance card to enroll the event in this study when they recognized that the emergency medical system activation was related to bathing (Supplementary material 1). When the emergency personnel brought the patients who were enrolled in this study to hospitals, the emergency personnel delivered the surveillance card for the physician (Supplementary material 2) to an attending physician. The list of symptoms on the surveillance card consisted of those that had been frequently identified in previous studies (12). Each physician-completed surveillance card was collected and sent by the chapters of the Japanese Medical Association to the study group.

Demographic data analyses

Using the 2012 Japanese Governmental Vital Statistics (http://www.e-stat.go.jp/SG1/estat/eStatTopPortal.do?method=init), the incidence of bath-related accidents by age was calculated. The incidence was defined as the total number of bath-related events per 100,000 people for 6 months from October. We calculated the 95% confidence intervals (CIs) of the rates using a beta-distribution.

Symptoms and diagnoses

To clarify the characteristics of bath-related non-fatal events, we focused on symptoms and diagnoses in the groups of survivors in need of help and patients with acute illness. Data on age, sex, vital signs, symptoms, findings of 12-lead electrocardiogram and head computed tomography (CT) as well as the disposition from the emergency department were obtained. The surveillance cards for the emergency personnel and physician (Supplementary material 1, 2) allowed for multiple answers to describe the symptoms and diagnoses.

Results

Number of events

During the study period, in total, 4,593 bath-related events were enrolled into this study from the 3 areas (Table 1). The surveillance card for the physician (Supplementary material 2) was delivered by the emergency personnel (Supplementary material 3). Of those, 75% were sent by the Japanese Medical Association chapters to the study group (Table 2).

Of the 4,593 events, 1,528 (33%) were identified as bath-related cardiac arrest events, and 935 (20%) were enrolled as survivors in need of help because of any difficulties, while 1,553 (34%) were classified as acute illness, and 577 (13%) had injuries related to bathing.

More than 80% of cases in the bath-related cardiac arrest and survivors in need of help groups occurred in individual baths. Of those, more than 90% occurred in the tub, while many events with acute illness and injuries occurred outside the tub. Emergency personnel also reported that 1,089 (79%) of the 1,374 sudden cardiac arrests inside the tub occurred when the victim's face was submerged in the tub water at the scene, whereas 854 survivors in need of help were found in the tub, and the faces of only 154 (18% of 854 survivors) of the victims were submerged in the tub water (Table 1).

Incidence

The incidence of bath-related events during the winter season from October 2012 to March 2013 were 9.84 cardiac arrest events per 100,000 people (95% CI: 9.35 to 10.35), 6.11 (5.72 to 6.52) survivors in need of help, 10.09 (9.59 to 10.60) cases of acute illness, and 3.78 (3.48 to 4.10) injuries (Table 3). The incidence by age also revealed that elderly people frequently experience such events.

Seasonal differences were noted for cases of cardiac arrest, survivor in need of help, and acute illness events (Fig. 1). All were frequently observed during the severe winter seasons from December to February, although injury events showed no seasonal differences.

Symptoms

The major symptoms associated with the reasons for activating the emergency medical system recognized by the emergency personnel were consciousness disturbance and exhaustion (Table 4). Chest pain was rarely identified. Attending physicians also recognized that the most frequent symptom and/or sign was a consciousness disorder (Table 5).

Diagnoses

Twelve-lead electrocardiograms and head CT images were obtained from 80% of the patients (Table 6). These images revealed that acute coronary or stroke events were uncommon among patients.

Table 1. The Number of Bath-related Accidents by the Actual Occurrence Sites.

n (%)	Cardiac arrest	Survivor in need of help	Acute illness	Injury	Total
Total	1,528 (100)	935 (100)	1,553 (100)	577 (100)	4,593 (100)
Inside the bathroom	1,461 (96)	907 (97)	1,031 (66)	445 (77)	3,844 (84)
Inside the tub	1,374 (90)	854 (91)	442 (28)	65 (11)	2,735 (60)
Submerged*	1,089 (71)	154 (16)	78 (5)	5 (1)	1,326 (29)
Outside the tub	87 (6)	53 (7)	589 (40)	380 (66)	1,109 (24)
Outside the bathroom	26 (2)	7 (1)	378 (24)	95 (16)	506 (11)
Not identified	41 (3)	21 (2)	144 (9)	37 (6)	243 (5)
Individual bath	1,416 (93)	759 (81)	962 (62)	384 (67)	3,521 (77)
Inside the bathroom	1,400 (92)	757 (81)	762 (49)	325 (56)	3,244 (71)
Inside the tub	1,320 (86)	709 (76)	344 (22)	57 (10)	2,430 (53)
Submerged*	1,039 (68)	95 (10)	48 (3)	4 (7)	1,186 (26)
Outside the tub	80 (5)	48 (5)	418 (27)	268 (46)	814 (18)
Outside the bathroom	16 (1)	2 (0)	200 (13)	59 (10)	277 (6)
Public bath	71 (5)	155 (17)	447 (29)	156 (27)	829 (18)
Inside the bathroom	61 (4)	150 (16)	269 (17)	120 (21)	600 (13)
Inside the tub	54 (4)	145 (16)	98 (6)	8 (1)	305 (7)
Submerged*	50 (3)	59 (6)	30 (2)	1 (0)	140 (3)
Outside the tub	7 (0)	5 (1)	171 (11)	112 (19)	295 (6)
Outside the bathroom	10 (1)	5 (1)	178 (11)	36 (6)	229 (5)

*: Submerged victim's face in tub-water

The attending physicians did not give diagnoses of organic diseases in more than 80% of the patients (Table 7). Of those, over 40% had a consciousness disorder, including transient loss of consciousness and syncope, while less than 20% had had a stroke and/or heart attack. Those diagnoses at the emergency department were characterized as functional disorders without any organic disease.

Vital signs

Vital signs at the scene showed that more than half of the patients had disturbed consciousness (Fig. 2). Many patients had hyperpyrexia of ≥37°C. In particular, 30% of survivors in need of help had a body temperature over 38°C (Fig. 3), while a systolic blood pressure of <80 mmHg, which can cause unconsciousness, was rare (Fig. 4). A significant positive correlation was observed between the consciousness level and body temperature (Spearman's rank correlation, survivor in need of help: $r=0.27$, $p<0.001$, acute illness: $r=0.25$, $p<0.001$), whereas there was no significant correlation between the consciousness level and systolic blood pressure (Fig. 5, $r=0.02$, $p=0.40$, $r=0.05$, $p=0.053$, respectively).

Discussion

This study is the first report elucidating the incidence and characteristics of bath-related accidents, including non-fatal events based on a prospective survey of all the emergency events related to bathing. Most frequent symptoms in those accidents were consciousness disturbance and exhaustion, which is characterized as a functional disorder without any organic disease. Acute coronary syndrome and acute stroke were caused infrequently during bathing. Hyperthermia was observed among the patients at the scene by emergency personnel. Their conscious level correlated with their body temperature. Therefore, this study suggested that an elevation of body temperature during hot water immersion can trigger such an event.

This study showed that accidents, including cardiac arrest, frequently occur in Japan. To our knowledge, this is the first report describing whole accidents related to bathing, although previous studies have reported that bath-related sudden death is frequently observed in Japan (1-4, 6-8, 10, 11). Of the 4,593 bath-related events, there were 935 survivors in need of help and 1,553 events with acute illness (20% and 34%, respectively, Table 1). This strongly suggested that investigating victims rescued from a tub plays a crucial role in clarifying the mechanisms underlying bath-related sudden death. When attempting elucidate the mechanisms surrounding this fatal condition, the pathophysiological phenomena observed in the survivors can prompt speculation regarding the process of the patient's death. Although most previous reports regarding bath-related accidents have focused on lethal events only (1-4, 6-8, 10, 11), those including autopsied investigations failed to mention the cause of death. Establishing the mechanism and strategy for preventing bath-related sudden death is unavoidably hampered when researchers focus on lethal events only.

The group of survivors in need of help might be a target group for clarifying the mechanism underlying bath-related death phenomena. The present study found that events involving survivors in need of help and those involving cardiac arrest have similar characteristics. Both events were fre-

Table 2. Delivered and Collected Surveillance Cards for the Physicians.

	n (%)	Total	Surveillance card from medical facilities				
			Collected				Not collected
			Total	Emergency department disposition			
				Death	Admission	Discharge	
Tokyo Metropolis	Cardiac arrest	750 (100)	566 (75)	543 (72)	23 (3)	0 (0)	184 (25)
	Survivor in need of help	704 (100)	531 (75)	0 (0)	276 (39)	255 (36)	173 (25)
	Acute illness	1,011 (100)	767 (76)	526 (52)	6 (1)	235 (23)	244 (24)
	Injury	446 (100)	351 (79)	273 (61)	1 (0)	77 (17)	95 (21)
Yamagata Prefecture	Cardiac arrest	120 (100)	106 (88)	103 (86)	3 (3)	0 (0)	14 (12)
	Survivor in need of help	94 (100)	77 (82)	0 (0)	38 (40)	39 (41)	17 (18)
	Acute illness	218 (100)	186 (85)	0 (0)	66 (30)	120 (55)	32 (15)
	Injury	51 (100)	45 (88)	0 (0)	20 (39)	25 (49)	6 (12)
Saga Prefecture	Cardiac arrest	68 (100)	39 (57)	34 (50)	5 (7)	0 (0)	29 (43)
	Survivor in need of help	52 (100)	28 (54)	1 (2)	17 (33)	10 (19)	24 (46)
	Acute illness	172 (100)	97 (56)	2 (1)	40 (23)	55 (32)	75 (44)
	Injury	61 (100)	35 (57)	0 (0)	17 (28)	18 (30)	26 (43)
Total	Cardiac arrest	938 (100)	711 (76)	680 (72)	31 (3)	0 (0)	227 (24)
	Survivor in need of help	850 (100)	636 (75)	1 (0)	331 (39)	304 (36)	224 (26)
	Acute illness	1,401 (100)	1,050 (75)	8 (1)	341 (24)	701 (50)	351 (25)
	Injury	558 (100)	431 (77)	1 (0)	114 (20)	316 (57)	127 (23)
	Total	3,747 (100)	2,828 (75)	690 (18)	817 (22)	1,321 (35)	929 (25)

quently observed in elderly people (Table 3) and showed seasonal differences (Fig. 1). In addition, most of the survivors in need of help were similar to those who experienced cardiac arrest (Table 1). Although acute illness also frequently occurred in elderly people with a seasonal difference, many of the patients with acute illness had episodes that occurred outside the tub (Table 1, Fig. 6).

The findings in this study suggest that heat illness, including heat stroke, heat exhaustion, and heat syncope, cause many bath-related accidents. The major symptoms and signs in survivors in need of help were described as functional disorders that influence consciousness and lethargy. Furthermore, the level of consciousness was significantly correlated with body temperature (Fig. 5), suggesting that body temperature during hot water immersion plays a key role in the etiology of bath-related accidents. Under this hypothesis, consciousness disorders and lethargy may spontaneously recover when the body temperature decreases. Indeed, more than half of the survivors in need of help and having acute illnesses were discharged from the emergency department (Table 1), which reflected that their medical problems were self-limiting and spontaneously recovered. When bathers exit the tub, their bodies rapidly cool. We therefore found no evidence supporting the diagnosis of such a condition in the hospital setting, when patients are brought to the emergency department.

These findings suggested that consciousness disturbance followed by drowning occurs in the process of bath-related death. Most of the deaths occurred while the victims bathed in a tub filled with hot water in a private bathroom. Indeed, emergency personnel reported that over 90% of events occurred while in the tub, and victims' faces were submerged in the tub water at the scene in approximately 80% of cases. Although most of the survivors in need of help were also

Table 3. The Incidence of Bathing-related Accidents between October 2012 and March 2013.

Age	Cardiac arrest	Survivor in need of help	Acute illness	Injury
	incidence per 100,000 persons (95% confidence interval)			
0-4	0.33 (0.04-1.20)	1.96 (1.01-3.42)	8.97 (6.76-11.68)	6.04 (4.25-8.32)
5-9	0.00 (0.00-0.63)	0.51 (0.11-1.49)	1.36 (0.59-2.68)	2.38 (1.30-4.00)
10-14	0.00 (0.00-0.61)	0.16 (0.00-0.92)	2.47 (1.38-4.07)	2.14 (1.14-3.66)
15-19	0.48 (0.10-1.40)	0.00 (0.00-0.59)	1.76 (0.88-3.14)	1.12 (0.45-2.30)
20-24	0.25 (0.03-0.90)	0.12 (0.00-0.67)	3.97 (2.72-5.61)	1.61 (0.86-2.76)
25-29	0.39 (0.10-0.99)	0.10 (0.00-0.54)	2.02 (1.25-3.09)	1.64 (0.95-2.62)
30-34	0.61 (0.25-1.26)	0.18 (0.02-0.63)	1.84 (1.14-2.81)	1.23 (0.67-2.06)
35-39	0.64 (0.28-1.26)	0.00 (0.00-0.29)	1.68 (1.04-2.57)	0.96 (0.50-1.68)
40-44	0.55 (0.22-1.13)	0.39 (0.13-0.91)	2.74 (1.91-3.81)	1.10 (0.60-1.84)
45-49	1.28 (0.70-2.14)	0.55 (0.20-1.19)	2.92 (2.00-4.12)	1.37 (0.77-2.26)
50-54	1.41 (0.75-2.40)	0.76 (0.30-1.56)	4.43 (3.18-6.02)	1.41 (0.75-2.40)
55-59	2.98 (1.93-4.39)	0.83 (0.34-1.72)	4.76 (3.40-6.49)	2.26 (1.36-3.53)
60-64	6.20 (4.76-7.93)	3.54 (2.48-4.90)	7.87 (6.24-9.79)	4.62 (3.40-6.15)
65-69	10.61 (8.58-12.97)	6.81 (5.21-8.75)	14.07 (11.72-16.75)	5.70 (4.24-7.49)
70-74	22.49 (19.31-26.05)	13.40 (10.97-16.20)	25.15 (21.78-28.89)	5.69 (4.15-7.61)
75-79	38.98 (35.39-45.01)	29.62 (25.69-33.99)	36.19 (31.82-40.98)	10.51 (8.22-13.23)
≥80	83.56 (77.86-89.57)	49.86 (45.48-54.56)	57.00 (52.31-62.00)	17.85 (15.26-10.74)
Total	9.84 (9.35-10.35)	6.11 (5.72-6.52)	10.09 (9.59-10.60)	3.78 (3.48-4.10)

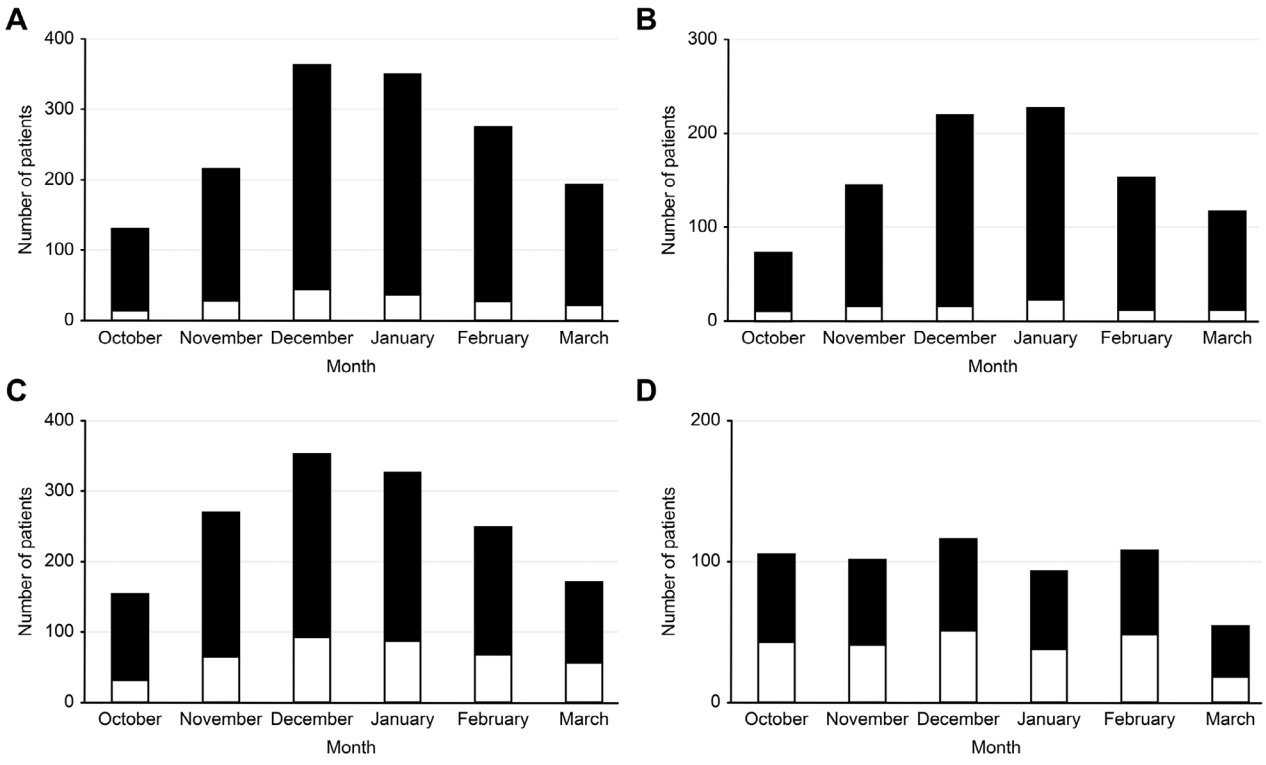

Figure 1. The monthly distribution of the number of bath-related accidents. Black bars show the number of elderly people ≥65 years of age. White bars show the number of non-elderly people <65 years of age. A) Cardiac arrest. B) Survivor in need of help. C) Acute illness. D) Injury. These monthly distributions of the number of accidents show that cardiac arrest, survivor in need of help, and acute illness occur frequently during colder months.

found in a tub filled with hot water, their faces were infrequently submerged in the tub water (Fig. 6). Recent studies based on autopsies have reported that water inhalation is observed in the majority of sudden-death events (3, 7, 8, 10), suggesting that drowning is strongly associated with death in such cases. When the victim's face was not submerged in the tub water, most could be rescued. If they were not found in time, however, and their face remained in the tub water, victims often sank into the tub water and experienced cardiac arrest. Indeed, sudden death was infrequently observed in public baths in this study (Table 1). This suggested that bystanders were able to recognize unconsciousness early and rescue the victim. Therefore, the early recognition of consciousness disturbance and drowning may be an important preventive strategy. Furthermore, preventing hyperthermia during hot water immersion seems to be essential.

We hypothesized that hot water immersion causes heat illness. Previous animal studies have revealed that hyperthermia during hot water immersion causes lethal events (9). Our findings and hypothesis emphasized that the quantity of

Table 4. Symptoms Recognized by Emergency Personnel.

Symptom (multiple answers)	Survivor in need of help n=935 (%)	Acute illness n=1,553 (%)
Consciousness disturbance	451 (48)	641 (41)
Exhaustion	646 (69)	646 (42)
Dyspnea	34 (4)	44 (3)
Chest pain	7 (1)	26 (2)
Dizziness	7 (1)	72 (5)
Trauma	15 (2)	72 (5)
Others	17 (2)	60 (4)

Table 5. Symptoms and Signs Recognized by Attending Physicians.

Symptom/sign (multiple answers)	Survivor in need of help n=530* (%)	Acute illness n=820* (%)
Decreased level of consciousness	160 (30)	167 (20)
Transient loss of consciousness	260 (49)	460 (56)
Hypotension	19 (4)	20 (2)
Drowning	84 (16)	29 (4)
Dyspnea	57 (11)	32 (4)
Chest pain	3 (1)	21 (3)
Headache	4 (1)	39 (5)
Dizziness	14 (3)	43 (5)
Paralysis	24 (5)	38 (5)
Fall	18 (3)	59 (7)
Trauma	14 (3)	43 (5)

*Number of valid responses

Table 6. Findings of 12-lead Electrocardiogram and Head CT Imaging.

Findings	Survivor in need of help n (%)	Acute illness n (%)
12-lead electrocardiography	671 (100)	1,097 (100)
Obtained	538 (80.2)	839 (76.5)
Acute myocardial infarction	1 (0.1)	8 (0.7)
Old myocardial infarction	17 (2.5)	11 (1.0)
Ischemic change	13 (1.9)	12 (1.1)
Sinus tachycardia	51 (7.6)	31 (2.8)
Atrial fibrillation	35 (5.2)	52 (4.7)
Supraventricular tachycardia	4 (0.6)	5 (0.5)
Ventricular tachycardia	1 (0.1)	0 (0)
Left ventricular hypertrophy	15 (2.2)	20 (1.8)
Not obtained	133 (19.8)	258 (23.5)
Head CT imaging	645 (100)	1,173 (100)
Obtained	463 (71.8)	697 (68.1)
Subarachnoid hemorrhage	7 (1.1)	20 (1.7)
Intracerebral hemorrhage	26 (4.0)	43 (3.7)
Old cerebral infarction	87 (13.5)	97 (8.3)
Chronic subdural hematoma	11 (1.7)	9 (0.8)
Not obtained	182 (28.2)	374 (31.9)

Table 7. Diagnosis and Disposition at Emergency Department.

Diagnosis and disposition at emergency department	Survivor in need of help n (%)	Acute illness n (%)
Emergency department diagnosis	756 (100)	1,051 (100)
Functional disorders	616 (81.5)	873 (83.1)
Transient loss of consciousness	231 (30.6)	338 (32.2)
Consciousness disturbance	62 (8.2)	52 (4.9)
Syncope	71 (9.4)	161 (15.3)
Hypotension	39 (5.2)	84 (8.0)
Dizziness	4 (0.5)	34 (3.2)
Dehydration	154 (20.4)	175 (16.7)
Environmental accidents	55 (7.3)	29 (2.8)
Heat illness	43 (5.7)	21 (2.0)
Drowning	12 (1.6)	8 (0.8)
Organic diseases	91 (12.0)	175 (16.7)
Stroke	86 (11.4)	158 (15.0)
Subarachnoid hemorrhage	7 (0.9)	19 (1.8)
Intracerebral hemorrhage	23 (3.0)	40 (3.8)
Cerebral infarction	18 (2.4)	33 (3.1)
Transient ischemic attack	38 (5.0)	66 (6.3)
Cardiac diseases	5 (0.7)	17 (1.6)
Myocardial infarction	3 (0.4)	11 (1.0)
Heart failure	2 (0.3)	6 (0.6)
Miscellaneous	49 (6.5)	3 (0.3)
Disposition	636 (100)	1,050 (100)
Discharge	304 (47.8)	701 (66.8)
Admission	331 (52.0)	341 (32.5)
Death	1 (0.2)	8 (0.8)

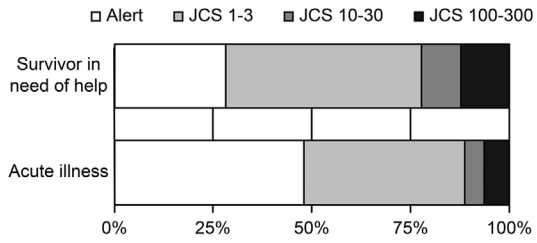

Figure 2. The level of consciousness at the scene using the Japan Coma Scale. Emergency personnel evaluated the level of consciousness of patients with bath-related accidents using the Japan Coma Scale (JCS) at the scene. More than half of the patients had disturbed consciousness.

heat during bathing plays a crucial role in the incidence of lethal events while bathing. In our view, bathing that is too long and/or too hot can be dangerous. In general, many Japanese people prefer to have hotter and longer immersions during the cold winter season. To prevent bath-related accidents, including cardiac arrest, bathing with lower heat may be essential. We recently recommended bathing in water of <41°C for 10 minutes based on a simulated study regarding the body temperature change during hot water immersion (13).

Cardiovascular events were infrequently observed in this study, although most investigators previously suspected that the mechanism of the event was based on cardiovascular events (3-8, 10, 14). Previous medicolegal investigations revealed that cardiovascular events are not a major cause of death based on autopsy findings. This study was concordant with such medicolegal findings.

This study has several limitations. First, limited areas were analyzed. The residential environments and bathing habits vary throughout Japan. For example, it is well known that the residential environment is warmer in the Hokkaido area than in other regions, and people in Okinawa have different bathing customs from those in other areas. Second, the decision to enroll ambulance-activated events in this study was made by emergency personnel. We considered this manner of study the best way to collect comprehensive information regarding bath-related accidents, although there are no established criteria for defining bath-related accidents. Third, the surveillance card for physicians (Supplementary material 2) was delivered by the emergency personnel (Supplementary material 3) when the emergency personnel delivered the patients to the hospitals. Indeed, 25% of the delivered cards were not collected. From an etiological standpoint, this lack of information may result in major limitations. Finally, several findings suggested that bath-related events are caused by heat illness due to hot water immersion. Because most cases of heat illness are the result of a functional disorder, it is difficult to prove this hypothesis.

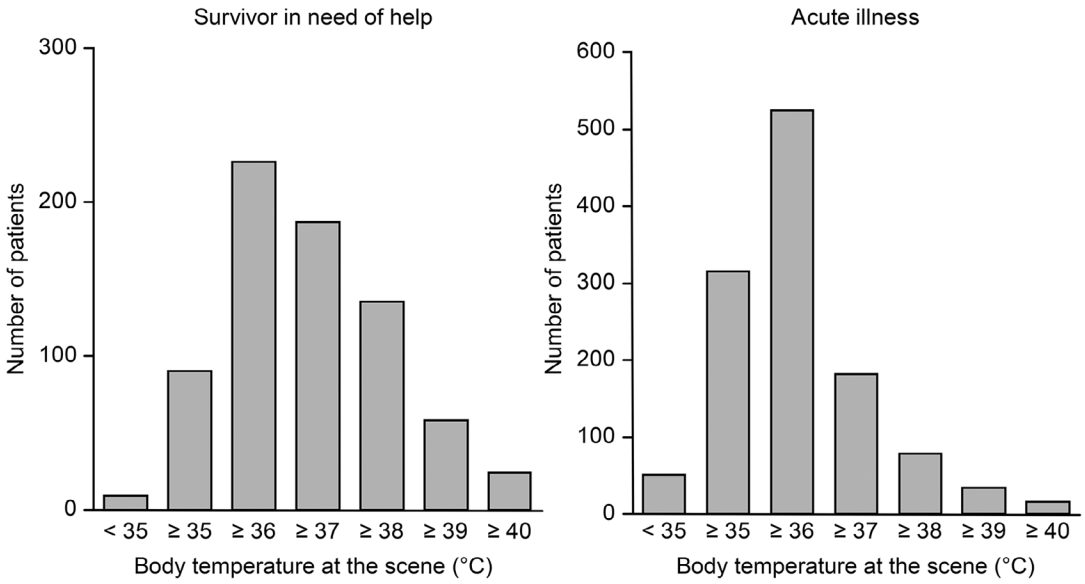

Figure 3. **The distribution of body temperature at the scene. Emergency personnel measured the body temperature of the patients with bath-related accidents at the scene. More than half of the survivors in need of help had hyperpyrexia with body temperatures exceeding 37.0°C. Of the patients with acute illness, 25% had hyperpyrexia.**

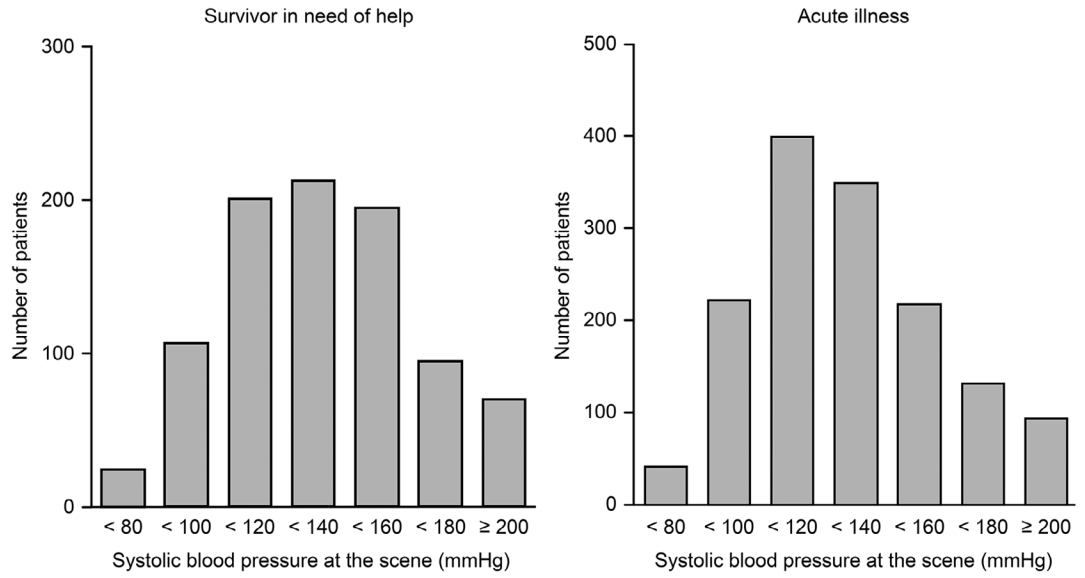

Figure 4. **The distribution of systolic blood pressure at the scene. Emergency personnel measured the systolic blood pressure of the patients with bath-related accidents at the scene. Less than 3% had a blood pressure of <80 mmHg, and less than 8% had a blood pressure of >200 mmHg.**

Despite these limitations, this is the first study containing significant findings regarding bath-related accidents.

In conclusion, we noted that accidents frequently occur in the bath. The most frequent symptoms in those accidents were consciousness disturbance and lethargy, which are characterized as functional disorders without any organic disease. Those findings suggest that heat illness during hot water immersion causes drowning and sudden death.

The authors state that they have no Conflict of Interest (COI).

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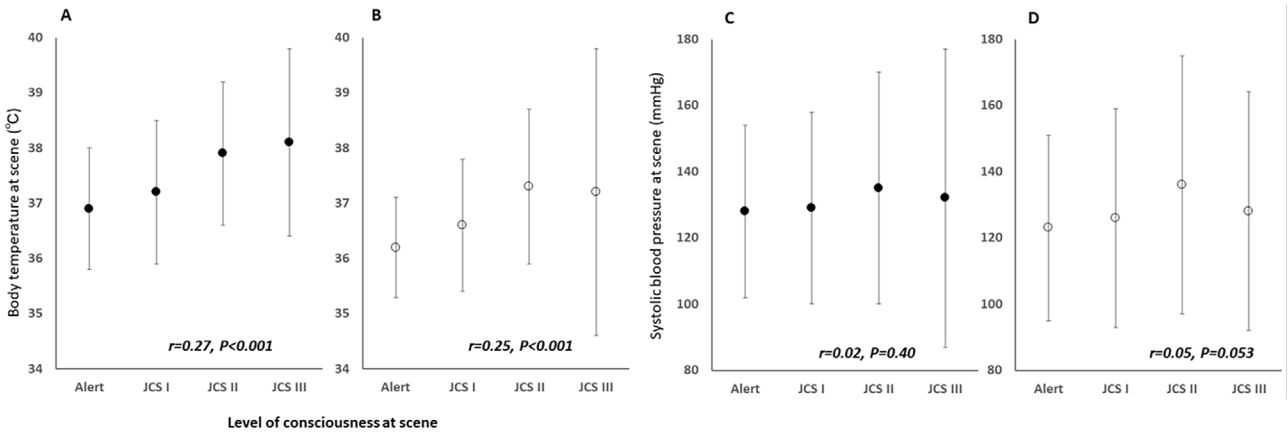

Figure 5. **Relationships between the consciousness level and the body temperature or systolic blood pressure at the scene. Closed circles show the average body temperature or systolic blood pressure of survivors in need of help, while open circles show those values in cases of acute illness. Error bars show the standard deviation. Emergency personnel evaluated the vital signs at the scene (Fig. 3 and 4). A significant positive correlation was observed between the consciousness level and body temperature [Spearman's rank correlation, survivor in need of help: r=27, p<0.001 (A), acute illness: r=0.25, p<0.001 (B)], whereas there was no significant correlation between the consciousness level and systolic blood pressure [r=0.02, p=0.40 (C), r=0.04, p=0.053 (D), respectively].**

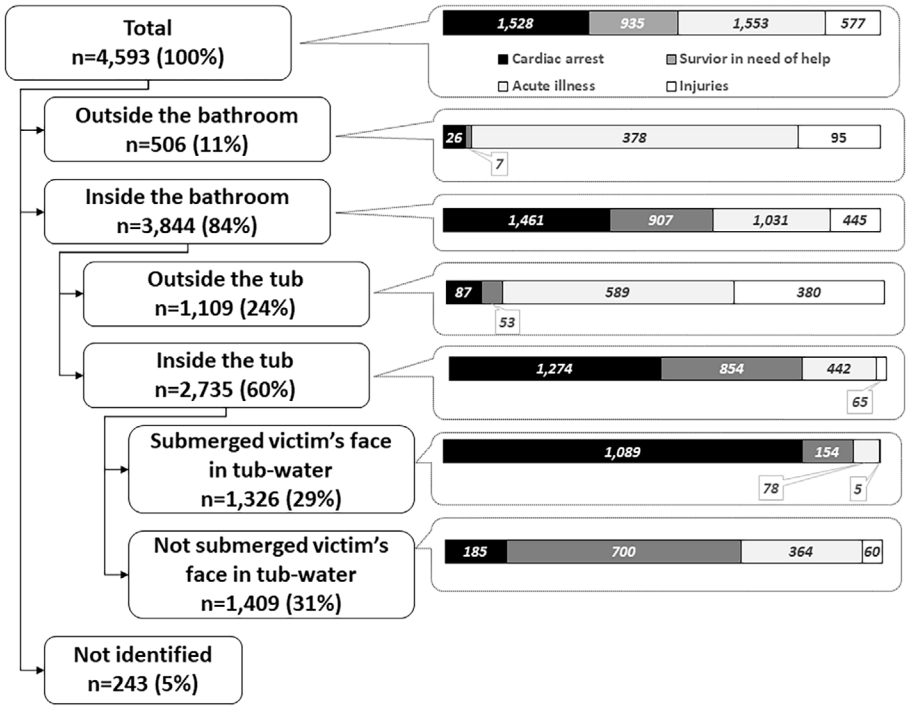

Figure 6. **Number of accidents and actual site of the accidents. This figure is reconstructed from the data in Table 1. Acute illness and injury occurred frequently outside the bathtub as well as outside the bathroom. Most of the cases of cardiac arrest and survivors in need of help occurred inside the bathroom. Most of the cases of cardiac arrest occurred in the tub, while many of the survivors in need of help were found outside the tub in the bathroom.**

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