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Bathtub drowning: An 11-year retrospective study in the state of Maryland

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ABSTRACT

A bathtub drowning is one of the leading causes of death in a bathtub. The purpose of this study was to evaluate how reliable the drowning-related signs could be for identifying a bathtub drowning in the cases of death in the bathtub. Performing a retrospective review of 92 deaths in the bathtub in Maryland, 71.7 percent were the presence of bathtub drowning and 28.3 percent were the absence of bathtub drowning. Three leading contributory causes of death were cardiovascular disease, drug/alcohol-related death, and seizure disorder in both groups. There was a statistically significant difference between the groups in relation to a history of recovery from the water (95.5% and 38.4%, $p < 0.001$), foam in the air way (33.3% and 15.4%, $p < 0.05$), watery fluid in the sphenoid sinuses (81.8% and 11.5%, $p < 0.05$), hyperinflated lungs (36.4% and 3.8%, $p < 0.01$), and watery fluid in the stomach contents (40.9% and 3.8%, $p < 0.01$). More than triple overlapped drowning-related signs could be beneficial for the diagnosis of a bathtub drowning. A comprehensive investigation incorporating a thorough scene investigation, gathering of the victim's medical and psychosocial history, and a meticulous full autopsy is necessary to elucidate both the cause and manner of death in these cases of death in the bathtub.

1. Introduction

Although bath culture varies by countries, the bathing style of sitting in a bathtub filled up with hot water has been widespread around the world. Consequently death in a bathtub involving adults, which is commonly unwitnessed, takes place in daily life [1]. Various causes have been considered, including drowning complicated by narcotic intoxication, drowning complicated by cardiovascular disease, drowning with a concomitant attack of unconsciousness, and death from natural causes without drowning [2–10]. The manner of death also has some variations. In most cases, victims were found unresponsive with their faces immersing or completely submerging under the bath water. The cases were required to determine if the subject died from an apparent disease while bathing or the subject died from drowning with a concomitant underlying etiology. Diagnosis of death in the bathtub used to be interpreted on the basis of all available individual background information involving past medical condition, scene investigation, postmortem imaging, autopsy findings, and toxicological analyses.

A bathtub drowning is one of the leading causes of death in the bathtub. It is mostly accidental; however, adults who are capable of taking a bath are not likely to drown in a home bathtub. One of the reasons for a bathtub drowning would be associated with comorbid factors which cause unconsciousness prior to drowning. If a certain case is suspected to be complicated by drowning, evidence of a bathtub drowning and a pre-existing illness which causes loss of consciousness must be ascertained during the autopsy. However, the main issue is that there are no unequivocal autopsy findings to indicate evidence of a bathtub drowning. Although it is believed in the literature that such a finding as the presence of watery fluid in the stomach contents is considered one of the noteworthy signs of a bathtub drowning [11], there are no studies on the basis of sufficient evidence. For this purpose, we carried out a retrospective study to evaluate how reliable the drowning-related signs could be for identifying a bathtub drowning in the cases of death in the bathtub.

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2. Materials and methods

2.1. Study design and subjects

This study was performed at the Office of the Chief Medical Examiner for the State of Maryland in the United States. In this study, over an 11-years period from January 2003 to December 2013, we retrospectively reviewed the records of subjects who unexpectedly died in the bathtub while bathing. The records included autopsy reports, autopsy notes, autopsy sketches, photographs, toxicological reports, preliminary investigation reports, and preliminary police reports.

A total of 115 cases were found in the study period. All cases exhibited that the subjects were found unresponsive in the bathtub filled with water, regardless of whether their face was submerged or not. Trauma is not contributing to the cause of death in all cases.

Of these, 4 cases were excluded due to partially inaccessible reports. Additionally, 8 cases were excluded because full autopsies were not performed. 5 cases were also excluded because decomposition changes interfered with the evaluation of the amount of fluid in the cavities. Finally 6 cases were excluded because children under the age of 15 were inappropriate for this study. Thus, further analyses were carried out for a total of 92 cases.

Next, the following information was compiled in each case: age; gender; manner of death. We then collected the presence of drowning-related signs which were consistent with the cases of drowning in a river or the sea, involving the following findings: history whether the face was submerging under the bath water (history of recovery from the water); foam in the airway; watery fluid in the sphenoid sinuses; hyperinflated lungs (emphysema aquosum); watery fluid in the stomach contents. The presence of watery fluid in the sphenoid sinuses was defined positive once the sphenoid sinuses was moist or contained more than 0.5 mL of watery fluid. The presence of watery fluid in the stomach contents represented the liquid was separated from the solid components after collection and sedimentation of the gastric content. Furthermore, we studied drowning-related signs that overlapped in each case. Finally, we obtained the pathologic diagnoses in each case where a forensic pathologist had already determined on the basis of scene investigations, victim's medical and psychosocial histories, and autopsy findings. We then divided the cases into two groups: a group of deaths attributable to bathtub drowning (the presence of bathtub drowning group) and a group of deaths not attributable to bathtub drowning (the absence of bathtub drowning group). The distribution of contributory causes of death was assessed in both groups.

2.2. Statistical analyses

Statistical analyses were performed to evaluate the significant difference between the groups. The incidence of each drowning-related sign was compared using Pearson's chi-square test. The assessment of overlapped drowning-related signs in the diagnosis of a bathtub drowning was performed using Fisher's exact test. The *R version 3.1.2* was used for the statistical analyses.

3. Results

3.1. Profiles to death

Consisting of 92 victims in this study, 66 (72%) were the result of bathtub drowning; the remaining 26 (28%) revealed the absence of bathtub drowning. Therefore, we divided into two groups: 66 for the presence of the bathtub drowning and 26 for the absence of the bathtub drowning. The data of individual victims in both groups associated with age, gender, manner of death, cause of death, contributory factor of death, significant pathological/toxicological findings related to death, and the presence of each drowning-related sign are shown in Tables 1 and 2.

The bathtub drowning group was composed of 29 males and 37 females; the average age was 53.6 ± 19.3 years (range: 20–96 years); the distribution of manner of death, 1 natural, 44 accident, 8 suicide, and 13 undetermined. The group where there was absence of bathtub drowning was composed of 15 males and 11 females; the average age was 49.4 ± 12.3 years (range: 20–71years); the distribution of manner of death was 17 natural, 1 suicide, and 13 undetermined. A summary of both groups is shown in Table 3.

3.2. The distribution of contributory causes of death

The distribution of contributory causes of death in each group is shown in Table 4. Cardiovascular diseases in the bathtub drowning group consisted of 9 arteriosclerotic cardiovascular disease (ASCVD), 5 hypertensive arteriosclerotic cardiovascular disease (HASCVD), 2 hypertensive cardiovascular disease (HCVD), 2 dilated cardiomyopathy, 1 hemopericardium due to acute myocardial rupture, and 1 cardiac arrhythmia due to congenital bicuspid valve. Cardiovascular diseases in the absence of bathtub drowning group consisted of 4 ASCVD, 5 HASCVD, 1 HCVD, 1 AMI, and 1 cardiac arrhythmia due to myocardial fibrosis and coronary artery abnormality. Drug/alcohol intoxications in the bathtub drowning group consisted of 7 lethal dose of morphine, 4 multiple narcotic drug use, 5 combination of alcohol/narcotic drug use, 6 extremely-high blood ethanol level, 1 lethal dose of oxycodone, 2 toxic dose of zolpidem, 1 toxic dose of quetiapine, 1 toxic dose of diphenhydramine, and 1 toxic dose of acetaminophen. Drug/alcohol intoxications in the absence of bathtub drowning group consisted of 2 lethal dose of morphine, 2 lethal dose of cocaine, 1 lethal dose of methadone, 1 combination of alcohol/narcotic drug use, and 1 extremely-high blood ethanol level. Diagnosis of seizure disorder was based on a past medical history, cerebral lesions causing seizure disorder through a histological examination, and the presence of tongue hemorrhage consistent with tongue bite. Seizure disorder consisted of 6 in the bathtub drowning group and 2 in the absence of bathtub drowning group. Central nervous system diseases contributing to bathtub drowning consisted of 3 cases, which includes multiple sclerosis (case 7), Huntington disease (case 53), and progressive supranuclear palsy (case 58). There were 2 of complications of chronic alcohol abuse in the absence of bathtub drowning group (case 68 and 82). There were 6 of unknown etiology complicated by drowning. Other included pneumonia (case 49), metastatic cancer (case 54), and inanition (case 56) in the bathtub drowning group, and asthma (case 72), ruptured basilar artery aneurysm (case 74), and diabetic ketoacidosis (case 83) in the absence of the bathtub drowning group.

3.3. Comparison of the presence of each drowning-related sign between the bathtub drowning and the absence of bathtub drowning

The relationship between the incidence of each drowning-related sign and the presence/absence of bathtub drowning is shown in Table 5. In the bathtub drowning group, 63 victims out of 66 victims (95.5%) were found the face submerging under the water; whereas 10 out of 26 (38.4%) in the absence of bathtub drowning group. There was a statistically significant difference between the groups in regard to history of recovery from the water ($\chi^2 = 33.58$; $p < 0.001$). Foam appeared in the airway in 22 out of 66 (33.3%) in the bathtub drowning group; whereas