

Bodies Recovered from Wells, Sewerage Systems and Pits: What is the Cause of Death?†

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Abstract

Introduction: The aim of this study was to determine the problems encountered during investigations into causes of death in corpses found in wells, sewer systems and pits, and to seek solutions to the problems. In fact, wells, sewer systems and pits have some common characteristics which may cause the problems. They contain water, have a hypoxic/anoxic environment and prevent corpses from being recognised. **Materials and Methods:** Based on the data obtained from the 1st Specialization Board of the Council of Forensic Medicine, affiliated with the Ministry of Justice, we retrospectively reviewed 69 corpses found in wells, sewer systems and pits between 1 January 1992 and 31 December 2002. Data on age, sex, crime scene and causes of death were obtained and evaluated using the SPSS 11.0 package programme. **Results:** Of 69 cases, 69.1% were male and 33.4% were aged 0 to 10 years. Fifty-eight per cent and 13.1% of the cases were found in wells and sewer systems respectively. Forty-three (62.3%) cases were found in a place with water. However, 34.9% of them had not drowned. The most frequent cause of death was drowning (40.6%). The cause of death was unknown in 18.8% of the cases. 15.9% of the corpses were exhumed to determine the cause of death. Twenty-six cases (37.7%) had signs of putrefaction and the cause of death was not determined in 9 cases. Diatom was investigated in 42.0% of the cases (29 cases), but 17 cases did not have diatom. **Conclusion:** It is a complicated process to determine the causes of death in bodies recovered from wells, pits, water supplies and sewer systems, etc. Thorough forensic investigations are required because death may result from a wide variety of factors, and lesions on the corpses may undergo some changes quickly or can be covered in wells, pits and water supplies. A complete crime scene investigation, a thorough autopsy and histopathological, toxicological and biochemical examinations would prevent potential problems in determining the causes of death in bodies recovered from wells, sewer systems and pits. Almost one-third of the bodies recovered from wells, sewer systems and pits were aged 10 years or younger, which indicates a public health problem. Extra safety precautions will help to solve this problem.

Ann Acad Med Singapore 2006;35:547-51

Key words: Autopsy, Drowning, Postmortem investigation

Introduction

It may be difficult to determine the identities, and cause and time of death in corpses found in wells, sewer systems and pits because they may contain water, and there may not be sufficient oxygen, which leads to anoxia/hypoxia. Corpses found in wells, sewer systems and pits are difficult to recognise and therefore, they may remain there for a long time, resulting in disintegration and putrefaction. Death may result from trauma before or after the victim is thrown into the water, or from water aspiration, or it may instantly

occur due to sympathetic inhibition, parasympathetic stimulation or hypothermia when the victim is thrown into cold water. Miscellaneous conditions may also be responsible for death.

The aim of this study was to determine the problems with investigations into causes of death in corpses found in wells, sewer systems and pits, which may cause hypoxia/anoxia because of their depth and gas content, thus preventing corpses from being recognised whether they contain water or not.

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†This paper was presented as a poster presentation at the 8th Cross Channel Conference, Brugge, Belgium from 20 to 24 April 2004.

Materials and Methods

In Turkey, autopsies are performed by forensic medical specialists who work in the Department of Forensic Medicine at university hospitals, the Directorate of the Council of Forensic Medicine, which is affiliated with the Ministry of Justice and the affiliates and branches of the directorate. If there is no forensic medical specialist, general practitioners perform autopsies. The Directorate of the Council of Forensic Medicine is located in Istanbul. The directorate includes 6 specialisation boards, a general board of directors and departments of Morgue, Physics, Chemistry, Biology, Traffic and Supervision, all of which offer forensic services both in Istanbul and in the rest of Turkey. When the cause of death cannot be determined in the Morgue Department and at autopsies performed in other institutions such as university hospitals, the First Specialization Board, an affiliate of the directorate, is requested to evaluate the case. The First Specialization Board includes 3 forensic medical specialists, 1 medical pathologist, 1 internist, 1 cardiologist, 1 anaesthetist, 1 general surgeon, 1 paediatrician, 1 gynaecologist, 1 neurosurgeon and forensic specialists who write reports. This board evaluates data recorded at death investigations, autopsies and crime scene investigations and gives a verdict on the cause of death and other relevant issues.

We retrospectively reviewed 69 cases found dead in wells, sewer systems and pits between 1 January 1992 and 31 December 2002. Data were obtained from the Council of Forensic Medicine, affiliated with the Ministry of Justice. Data on age, sex, crime scene and causes of death were obtained and evaluated using the SPSS 11.0 package programme.

Results

Forty-seven cases (68.1%), referred to the First Specialization Board of the Directorate of the Council of Forensic Medicine in order to confirm the cause of death, were first evaluated by branches of the directorate located in the cities other than Istanbul. An autopsy was performed by forensic medical specialists in 41 out of 69 cases (59.4%). In 15 cases (21.7%) death investigations were performed by general practitioners; however, in these cases, an autopsy was either not performed or was incomplete.

Eleven corpses (15.9%) had been exhumed to determine the cause of death. Three of them had not undergone an autopsy, but 8 had. Specimens had not been taken for toxicological examination in 23.2% of the cases and for histological examination in 16.3% of the cases (7/43) in which putrefaction did not develop.

We failed to determine sex in only 1 out of 69 cases. Forty-seven cases (69.1%) were male and 21 (30.9%) were

female. Twenty-three cases (33.4%) were aged between 0 and 10 years old, but we could not determine the age in 4 cases (Table 1). Fifty-eight per cent and 13.1% of the cases (n=40) were found in a well and a sewer system respectively (Table 2). The most frequent cause of death was drowning. In fact, 40.6% of the cases (n = 28) were found to have drowned (Table 3). However, the cause of death was unknown in 18.8% of the cases (n = 13).

In corpses found in wells, the cause of death was drowning in 21 cases (52.5%), a trauma-related intracranial lesion alone or a trauma-related intracranial lesion accompanied by cranial fractures in 4 cases, asphyxia in 4 cases and toxicity in 1 case, while the cause was unknown in 9 cases (22.5%). As for the 9 corpses found in the sewer system, the cause of death was drowning in 2 cases and trauma in 2 cases, but it was unknown in 3 cases. In 6 corpses found in the water supply, the cause of death was drowning in 2 cases, medullar shock due to neck trauma, gunshot wound, anoxia due to lack of oxygen, an intracranial lesion alone or an intracranial lesion accompanied by cranial fractures in the rest. In corpses found in pits, the cause of death was drowning in 3 cases, miscellaneous in 2 cases and unknown in 1 case. The distribution of causes of death by crime scene is shown in Table 4.

Out of 40 wells where the corpses were found, only 27 contained water, while 2 did not have water and there was

Table 1. Distribution of Cases by Age Groups

Age group (y)	n	%
0-10	23	33.4
11-20	12	17.4
21-30	7	10.1
31-40	7	10.1
41-50	7	10.1
51-60	3	4.4
61-70	4	5.8
71 and over	2	2.9
Unknown	4	5.8
Total	69	100.0

Table 2. Distribution of Cases by Crime Scenes

Crime scene	n	%
Wells	40	58.0
Sewer systems	9	13.1
Water supplies	6	8.7
Pits	6	8.7
Water purification plants	3	4.4
Hold of a ship	2	2.9
Fuel tank	1	1.4
Tunnel	1	1.4
Mines	1	1.4
Total	69	100.0

Table 3. Causes of Death

Cause of death	n	%
Drowning alone or in combination with another condition	28	40.6
Drowning	27	
Drowning plus electrocution	1	
Asphyxia alone or in combination with another condition	11	15.9
Asphyxia due to lack of oxygen	6	
Asphyxia due to an epileptic fit	1	
Asphyxia due to electrocution and lack of oxygen	1	
Mechanical asphyxia due to strangulation with a cord	1	
Asphyxia due to suffocation with a plug	1	
Asphyxia due to soil aspiration	1	
Trauma	9	13.1
Intracranial lesion alone or in combination with cranial fractures	5	
Medullar shock due to neck trauma	1	
Bleeding due to slitting the throat	1	
Cranial fractures and brain damage due to gunshot wounds	1	
Blunt traumatic lesions caused by a fall into a sewer system	1	
Toxicity alone or in combination with another condition	4	5.8
H2S toxicity	2	
Toxicity with unknown toxic substances	1	
Morphine and its derivatives	1	
Miscellaneous	4	5.8
Unknown deaths caused by force	3	
Hunger, cold and thirst (dehydration)	1	
Unknown	13	18.8
Total	69	100.0

Table 4. Distribution of Causes of Death by Crime Scenes

	Wells	Sewer systems	Water supplies	Pits	Miscellaneous	Total
Drowning	21	2	2	3	-	28
Asphyxia	4	1	1	-	5	11
Trauma	4	2	3	-	-	9
Toxicity	1	-	-	-	3	4
Miscellaneous	1	1	-	2	-	4
Unknown	9	3	-	1	-	13
Total	40	9	6	6	8	69

no information on whether the rest contained water. Five sewers, 5 water supplies and 4 pits contained water. Therefore, 43 places (62.3%) where the corpses were found had water. However, 34.9% of the cases found in these places (n = 15) had not died from drowning (Table 5).

Diatom was investigated in 29 cases (42.0%) and 12 of them were found to have diatom. Bone marrow was present in only 2 cases with diatom. Seven cases had diatom only in their lungs and 3 cases had diatom in their lungs, liver and brain.

Table 5. Distribution of Causes of Death in Corpses Found in Places with Water

	Wells	Sewer systems	Water supplies	Pits	Miscellaneous	Total
Water was present and the cause of death was drowning	15	1	2	3	-	21
Water was present, but the cause of death was not drowning	6	3	3	1	2	15
Water was present and the cause of death was unknown	6	1	-	-	-	7
Total	27	5	5	4	2	43

Table 6. Problems Encountered During Investigations for the Cause of Death

Problems Encountered in Decision Making Process	n	%
Concerning identification		
Failure to determine age	4/69	5.8
Failure to determine gender	1/69	1.4
Failure to perform autopsy in time/incomplete autopsy	15/69	21.7
Failure to perform histopathological examination on time	36/43	16.3
Failure to perform toxicological examination on time	16/69	23.2
Failure to investigate diatom although the corpse had been out of water	14/43	32.6
Putrefaction	26/69	37.7
No eyewitness	48/69	69.6

There were signs of putrefaction in 26 cases (37.7%). Of 13 cases in which the cause of death had not been detected, 9 were found to have drowned, and 7 of 21 cases were found to have signs of putrefaction. Only 8 putrefied corpses were subjected to investigations for diatom and half of them (30.8%) did not have diatom. There was a witness only in 30.4% of cases (n = 21). In addition, the identities of the corpses could be detected in 95.7% of the cases (n = 66). Problems encountered during investigations for the causes of death are shown in Table 6.

Discussion

In this study, we attempted to investigate causes of death in corpses found in wells, sewer systems, and pits, etc, and found that 69.1% of cases were male and that the male to female ratio was 2.2. In a study of corpses found in New York waterways,¹ the male-to-female ratio was 4:1 and in another study in Finland, it was 3.4:1.² The ratio of females

to males was much higher in Turkey than that in other countries.

In the present study, 33.4% of the cases were aged between 0 and 10 years old and 50.8% of the cases were 20 years old or younger. In the study on corpses in New York waterways¹, 69% of cases were aged between 21 and 50 years old and in the study in Finland,² 69.6% of the cases were aged between 25 and 64 years old. The number of children and adolescents found dead was higher in Turkey than in the other countries. This may be explained by the fact that water wells, sewer systems, etc. are located near houses in Turkey, which poses a danger to children. It is known that drowning is one of the most important causes of death among children in the world.³ However, there is limited data on deaths in wells, sewer systems, etc. A study from Mexico revealed that children living in houses with wells are 7 times as likely to drown as those living in houses without wells.⁴ Children, forbidden to enter wells, sewers, and waterways, may be curious and try to enter such places. Therefore, parents should keep an eye on their children. Prohibition alone does not solve the problem and parents should take extra safety precautions to protect their children against the danger caused by wells, sewers and waterways. For example, wells could be closed tight, so that children cannot open them. If they are to be used, parents should always remember the perils to which their children are subjected and explain the dangers of entering wells to their children in an appropriate way. Furthermore, both children and their families residing where water is supplied by wells and waterways should be offered education about the potential dangers.

The most frequent cause of death was drowning alone or in combination with another condition (40.6%). As we mentioned before, it may be difficult to determine the time of death when the death is caused by a variety of mechanisms and when corpses have remained in wells, sewer systems, pits and water supplies for a long time. Above all, drowning does not cause specific physical signs and histological features.^{5,6} It is of interest that the cause of death was not drowning in more than one-third of corpses found in places with water. Twenty-nine out of 43 corpses found in places with water were subjected to investigations for diatom and only 12 were found to have diatom. Our findings show that drowning is not necessarily the cause of death in all corpses found in places with water and therefore they should be subjected to autopsy and all forensic investigations. Although the reliability and specificity of investigations for diatom are controversial, specimens for these investigations should be obtained from any corpses found in places with water. Of course, the forensic investigation team should be knowledgeable enough to collect the specimens.

It is noted in the literature that the diagnosis of drowning should be based on postmortem pathological changes, crime scene investigations, environmental characteristics, witness statements and medical history. It is debatable whether investigations for the presence of diatom are reliable.^{6,7} As there is no pathognomic sign of drowning, the diagnosis of which is based on exclusion of other causes of death, witness statements are of extreme importance in its diagnosis. However, we found that there were no eyewitnesses in 69.6% of the cases. It may be explained by the fact that the corpses were far from the residential areas.

In corpses found in a well, pit or sewer, rapid putrefaction makes it more difficult to determine the time and cause of death and the identity of the corpse. In addition, histological and toxicological investigations may be inconclusive. In one case, a 69-year-old woman with a history of a psychiatric disease who had been living in a residential home for the elderly had got lost. Two and a half years later, she was found in the sewer system in the garden of the institution. Investigations made on the scene and an autopsy showed extreme putrefaction, while an examination of the skeletal system and toxicological investigations did not reveal any pathological conditions. Then, the corpse was sent to the First Specialization Board of the Council of Forensic Medicine. The Board evaluated the results of the forensic investigations and the court documents, but unfortunately failed to determine the cause of death.

In fact, in this study, there were signs of putrefaction in one-third of the cases and the cause of death was unknown in about one-fifth of the cases (18.8%), which is higher than that reported in the literature.⁸ The findings from crime scene investigations, and autopsies including radiological, histopathological, biochemical and toxicological examinations and eyewitness statements, if present, were evaluated together to ascertain the precise causes of death and to distinguish between ante- and post-mortem lesions and between ante- and post-immersion lesions. Nine out of 13 cases in which the cause of death was unknown showed signs of putrefaction. In a study in Finland, 37.1% of the corpses taken out of water showed changes caused by putrefaction.⁶

The identity of the corpse is one of the important factors in determining the cause of death and even the manner of death. In the present study, the identity was known in 95.7% of the corpses, which is consistent with the literature.^{1,6}

Another factor which causes difficulties in determining the identity in corpses found in wells, pits, and water supplies, etc. is trauma. The cause of death was trauma in 9 cases, of which 5 had cranial fractures and/or intracranial lesion, 1 had medullar shock due to neck trauma, 1 had bleeding due to slitting, 1 had cranial fracture and brain

damage due to a gunshot wound and 1 had blunt traumatic lesions caused by a fall into the sewer system. Even in cases of drowning in a lake or the sea, corpses may be damaged as they may make contact with the ground and strike against stable objects in water, such as rocks, bridges or gangplanks. Living things in the water may also cause damage to corpses. In deaths which occur in wells, pits and sewer systems, etc, trauma caused by a fall from a height, is already present. Striking against surrounding objects may also cause severe damage in corpses. All these forms of damage may cause a murder by a blunt trauma to remain unresolved. All living things in these places, especially mice, can cause wounds in corpses. As a result, all lesions in corpses should be described in detail, and the obtained findings and the results of crime scene investigations should be evaluated together.

One of the most important things which should not be overlooked in forensic investigations into corpses found in deep places is asphyxia, likely to be caused by the gas content of these places. In this study, 7 deaths were caused by insufficient oxygen alone or another condition in combination with insufficient oxygen. Two deaths resulted from hydrogen sulfide (H₂S) toxicity and 1 death was thought to have been due to toxicity, although the causative agent could not be determined. As the depth increases, the amount of oxygen decreases but the amount of gases such as carbon dioxide (CO₂), carbon monoxide (CO), methane, hydrogen sulfide (H₂S) and nitrogen increase,^{9,10} and these gases may exist in tunnels, mines, food silos and sewer systems.¹⁰ Death scene gas analysis may also be useful. However, in this study, gas analysis was not performed. This may be that the staff who performed crime scene investigations did not have sufficient technical skill and knowledge. Recently, the staff who perform crime scene investigations have been equipped with knowledge and skill required for the investigations especially in big cities. Technical facilities have also improved. Instead, based on the data from crime scene investigations and autopsies, the results of histopathological, biological and toxicological examinations and court documents, including accounts of eyewitnesses and defendants, other causes of death were excluded before the verdict of anoxia due to gas-containing environment was made.

It is required that autopsies should be performed by forensic medical specialists, on time and appropriately, and that specimens should be collected and examined appropriately so that the postmortem interval, place of

death and origin, and above all, the cause of death can be determined. We found that the autopsy had not been performed on time or was incomplete in one-fifth of the cases and that specimens for toxicological examinations were not obtained in a similar proportion of the cases. These factors caused forensic medical specialists to have difficulties in evaluating forensic cases later. In fact, specialists of the First Specialization Board had to take account of the findings recorded in the court documents and then give their verdict.

In conclusion, in corpses found in wells, pits, water supplies and sewer systems, death may have been caused by a suicidal or an accidental asphyxia (asphyxia due to lack of oxygen, asphyxia caused by a disease such as epilepsy, already present, or asphyxia due to soil aspiration) or it may result from homicidal asphyxia (strangulation with a cord). As a result, determining the cause of death in such circumstances is fairly complicated. To overcome this difficulty, one should bear in mind that the causes of death may vary and evaluate crime scene evidence, witness statements, environmental characteristics, findings from an autopsy and the results of histopathological, toxicological and biochemical examinations together.

REFERENCES

1. Lucas J, Goldfeder LB, Gill JR. Bodies found in the waterways of New York City. *J Forensic Sci* 2002;47:137-41.
2. Lunetta P, Smith GS, Penttila A, Sajantila A. Undetermined drowning. *Med Sci Law* 2003;43:207-14.
3. Brenner RA. Childhood drowning is a global concern: prevention needs a multifaceted approach. *BMJ* 2002;324:1049-50.
4. Celis A. Home drowning among preschool age Mexican children. *Inj Prev* 1997;3:252-6.
5. Lawler W. Bodies recovered from water: a personal approach and consideration of difficulties. *J Clin Pathol* 1992;45:654-9.
6. Lunetta P, Penttila A, Sajantila A. Circumstances and macropathologic findings in 1590 consecutive cases of bodies found in water. *Am J Forensic Med Pathol* 2002;23:371-6.
7. Modell JH, Bellefleur M, Davis JH. Drowning without aspiration: Is this an appropriate diagnosis? *J Forensic Sci* 1999;44:1119-23.
8. Kulusayin O, Koc S. Death. In: Soysal Z, Cakalir C, editors. *Forensic Medicine (Turkish)*. 1st ed. Istanbul, Turkey: Cerrahpasa Medical School of Istanbul University Publication No. 224, Istanbul University Press and Film Center, 1999:104.
9. Gargi J, Thind AS. Death scene gas analysis in suspected methane asphyxia. *Am J Forensic Med Pathol* 1993;14:350-1.
10. Ozen C. *Brief Forensic Medicine Textbook (Turkish)*. 3rd ed. Istanbul, Turkey: Istanbul Medical School of Istanbul University Publication No. 111, Tas Press, Istanbul, 1983:280-7.