Hypothermia Deaths in Van Province (Turkey)
Y Hekimoglu, Y Etil, O Gumus, E Kartal, U Demir, M Asirdizer

ABSTRACT

Objective: The aims of this study were to evaluate autopsy findings in hypothermia-related deaths in Van Province (Turkey), the city which is near the Turkey-Iran border.

Methods: Autopsy reports of 43 hypothermia fatalities were retrospectively reviewed. Data about age, gender, nationality of cases, seasonality of deaths, crime scene findings, autopsy findings, manner of deaths, risk factors for hypothermia, other traumatic lesions and toxicology were obtained from autopsy records and scene investigation records.

Results: There were 36 males and 7 females. The mean age was 20.5. More than half of the cases died or were found dead in the spring months. All but one of the cases was found dead outdoors. There were common red colored livor mortis in 33 cases (76.7%), antemortem traumas in 16 cases (37.2%), cold erythema in 26 cases (60.5%), myxedema in one case, bloody discoloration in the synovial fluid in 11 (84.6%) cases, Wischnewski spots in 32 cases (74.4%).

Conclusion: Illegal refugees are an important social problem in Turkey. Hypothermia should be considered as a cause of death for refugees when they are found especially in the cold provinces. In the diagnosis of hypothermia bloody discoloration of the synovial fluid is confirmed to be a valuable finding. Wischnewski spots remain valuable for positive identification.

Keywords: Autopsy findings, crime scene findings, hypothermia, synovial fluid, Wischnewski spots

From: Department of Forensic Medicine, Medical Faculty of Yuzuncu Yil University, 65080, Van, Turkey.

Correspondence: Dr Y Hekimoglu, Department of Forensic Medicine, Medical Faculty of Yuzuncu Yil University, 65080, Van, Turkey. Fax: +90-4322251386, E-mail: evisim@gmail.com

This article was presented as an oral presentation at 13th International Anatolian Forensic Sciences Congress 05/2016, Germencik-Turkey.
INTRODUCTION

Systemic hypothermia is a decrease below 35°C of body core temperature (1). When the human body is exposed to hypothermia, it protects itself from possible damages due to hypothermia by giving different responses against different stages of cold stress. The most important responses are shivering, stimulation of chemical thermogenesis and peripheral vasoconstriction (2-4).

Deaths due to hypothermia are often seen under certain conditions and in communities that have a low socioeconomic level. The risk groups were defined as babies, elders, drug addicts, patients with mental illness, athletes, individuals exposed to substances that cause heat loss such as water, immobilized persons due to drug abuse and acute or chronic illnesses (2,5,6). Despite the general opinion that “hypothermia can be seen in only colder climates”, hypothermia can be seen in almost all climates (5, 7-11). According to a report dated 2004 by the National Center for Health Statistics of the United States (8), 16,555 persons died due to hypothermia between 1979 and 2002 years in the United States. This is 689 cases per year. In 2002, most hypothermia death occurred in Alaska which is near the North Pole region. This is expected, but the second most common place is New Mexico, which is an arid and semi-arid continental climate with desert climate in some regions (3).

In recent studies, the rate of deaths due to hypothermia was high in states that had a climate with a sudden temperature change and low evening temperatures (8, 12). Elbaz et al reported 169 hypothermia cases in Soroka University Medical Center (Israel) that has a desert climate characterized with low night temperatures in winter (5°C; 18°C in summer) from 1999 to 2005 (5). In a study reported by Brandstrom et al (9), 150 (72%) of the 207 deaths due to hypothermia occurred in rural area and 57 (28%) in urban area. The incidence of these fatalities in North Sweden was 6.1/100,000 in rural areas and 0.4/100,000 in urban areas.

Despite all of the advances in medicine, the number of hypothermia-related deaths is still high, and hypothermia is often underestimated in forensic applications. Hypothermia is diagnosed at a postmortem period by excluding the other causes of death because of a lack of any pathognomonic
and specific findings. Clues obtained in the crime scene investigation may arouse suspicion of a postmortem diagnosis of hypothermia. During scene investigations of hypothermia-related deaths, the existence of alcohol or drugs, lack or inadequacy of heaters, the existence of features suggestive of psychiatric disorders (clutter, decreasing self-care, etc.) are common (13).

The number of studies regarding hypothermia-related deaths and their medico-legal autopsy findings is limited. The aims of this study were to define the incidence of hypothermia-related deaths that occurred in Van Province (Turkey) and to describe some features such as age, gender, nationality, seasonality of deaths, crime scene findings, autopsy findings, manner of deaths, risk factors for hypothermia related deaths, other traumatic lesions and toxicology.

SUBJECTS AND METHODS

This is a retrospective review of autopsy reports and crime scene investigation data from 43 hypothermia-related fatalities in Van Province (Turkey) from June 1st, 2010 to May 31st, 2015. Data about age, gender, nationality of cases, seasonality of deaths, crime scene findings, autopsy findings, manner of deaths, risk factors for hypothermia, other traumatic lesions and toxicology were obtained from autopsy records and scene investigation records.

According to statistical data between 1950 and 2014 from the Turkish State Meteorological Service, (14) the low temperature was -28.7°C in winter and -2.6°C in summer. The mean temperature in January (the coldest month) was -3.4°C in Van Province (Table 1). The resulting data was statistically assessed by the Chi-square test, Kolmogorov Smirnov test, and Student’s t test. The statistical significance levels were set at 5%.
RESULTS

Forty-three (2.53%) of 1,699 deaths were evaluated by medico-legal autopsy in Van Province between June 1st, 2010 and May 31st, 2015. There were 4 cases between 2010 and 2011, 5 cases between 2011 and 2012, 9 cases between 2012 and 2013, 13 cases between 2013 and 2014, and 12 cases between 2014 and 2015. The average annual incidence of fatal hypothermia during the study period in Van Province was calculated as 0.8/100,000 persons for all cases and 0.2/100,000 persons for residents.

Of these cases, 36 (83.7%) were males and 7 (16.3%) were females (p < 0.05). The mean age was 20.5 (SD: 9.9; Median: 22; Min: 1; Max: 47) in males, 14.6 (SD: 10.6; Median: 17; Min: 2; Max: 25) in females, and 19.6 (SD: 10.2; Median: 22; Min: 1; Max: 47) in all cases. The majority of cases (n=23; 53.5%) was between 21 and 30 age range (p < 0.05) (Table 2). More than half of cases (n=28; 65.1%) died or were found dead in the spring months (p < 0.05) especially in April (n=14; 32.6%) (Figure 1). All but one of the cases (n = 42; 97.7%) was found dead outdoors (p < 0.05) especially in the mountainous region near the Turkey-Iran border (n = 23; 53.5%) (p < 0.05) (Table 3).

Of all cases, 8 (18.6%) were Turkish citizens and the rest (n = 35; 81.4%) were citizens of other countries. All cases that were found dead in the mountainous region near the Turkey-Iran border were foreigners. In evaluating external autopsy findings of all cases, the rectal temperature was not recorded in any case, but there were common red livor mortis in 33 cases (76.7%) (Figure 2). There were antemortem traumas in 16 cases (37.2%). Of these 16 cases, 2 were found at the bottom of a cliff but these trauma findings did not cause death alone. The traumatic findings in other cases were not lethal too. There was cold erythema in 26 cases (60.5%) (Figure 3), myxedema in one resident girl (2.3%) who died outdoor and was 17 years old.

In the internal examination, there was bloody discoloration in the synovial fluid in 11 (84.6%) of the 13 cases investigated on this subject (Figure 4), Wischnewski spots in 32 cases (74.4%) (Figure 5), hemorrhage, congestion and/or edema in the lungs in 22 (51.2%), enzymatic fat necrosis of the pancreas in 7 cases (16.3%), and congestion of liver and/or spleen in 20 cases (46.5%).
There was pancreatitis and hemorrhage in the psoas muscle, pectoralis minor muscle and the first intercostal muscle. There was congestion of the vena cava. There were differences in the left and right heart blood color. Studies of acute heart failure showed that there was dilatation of the right atrium and ventricle of the heart. There were also bronchopneumonia, acute tubular necrosis, and lipid deposits in the glomeruli, liver, heart and skeletal muscle. Focal myocardial degeneration and necrosis in the heart muscle were not reported in any autopsy.

Because the majority of cases were foreign nationals they had little medical history. These cases were not evaluated for psychiatric illness. Ethyl alcohol was detected in only one case who died in a prefabricated container; drugs were not detected in any case.

**DISCUSSION**

The climate of east and middle regions of Turkey is inclined to cause hypothermia. We encountered only one article of hypothermia-related deaths in Turkey in the literature. This contained 12 cases (15). Literature reports regarding autopsy in hypothermia-related deaths was limited worldwide. In many studies, the annual incidence of fatal hypothermia was reported between 0.2/100,000 and 6.1/100,000 persons (8–12). Here, the average annual incidence of fatal hypothermia during the study period in Van Province was 0.8/100,000 persons for all cases when including foreigners and 0.2/100,000 persons for residents. These rates are the first description of incidence due to hypothermia related deaths in Turkey; there was no prior definition of incidence on this subject (15).

We estimated that these rates will be lower than the values in this study if a study on this issue is carried out in other parts of the Turkey. Van Province of Turkey it is adjacent to the border with Iran and near the border with Iraq. Thus, this region is mountainous and is common with illegal immigrants. During illegal immigrant crossings, some refugees have died in the cold mountains due to hypothermia. Also there were four times as many dead from other countries as Turkey citizens. All of the cases in the mountainous region near the Turkey-Iran border were foreigners. Recently,
acceleration of civil war in Syria and Iraq as well as the ongoing civil war in Afghanistan has increased the illegal passage of refugees in this region.

Different studies on the distribution by age of death from hypothermia showed similar results. Bright et al (10), showed that the age ranged from 30 to 86 with a mean of 67 for 62 cases. Other studies have shown mean ages ranging between 62 and 68 (5, 10, 16–18). Dogan et al reported that the ages of the patients ranged from 41 to 85, and the mean age was 57.0±15.4 in their study involving 12 Turkish (15). Here, the mean age (19.6±10.2) was very low when compared to the results of the above mentioned studies. This difference can be explained in that both refugees and residents are young populations. However, 19 refugees in 2002 (not included in this study) and 7 refugees in 2015 died due of hypothermia in Van Province. Nearly all of them were young men and women and their little children.19,20 In a study of demographics about refugees in Van Province, 90% of the refugees were under 40 years old (21).

In previous studies, the majority of hypothermia-related deaths were in men (5, 9, 15, 18, 22-24). Ishikawa et al reported that 114 (70.4%) were male of 162 cases (17). Here, the majority of cases were males (83.7%). Females are more resistant to hypothermia than males because they have thicker subcutaneous fat layers that protects against hypothermia (2, 25).

Hypothermia increases in winter (15, 22). Tanaka et al showed that 117 (74.6%) of 157 cases of fatal hypothermia died during the winter months (22). Dogan et al showed that 41.7% of hypothermia-related deaths occurred in January. We found that most cases (n = 28; 65.1%) died or was found dead in the spring months especially in April (n = 14; 32.6%). This is likely because the corpses were covered with snowdrifts and were only visible once the snow melted in the spring. There is also increased migration in the spring. While there was evidence of scavenging by wild animals, there was no evidence of decay (Fig. 6).

Despite the general belief that fatal hypothermia occurs outdoors, many studies have shown that it can happen indoors at a rate of 7% to 79% (9, 16, 18, 28, 29). This study is odd in that all except one died outdoors.
One of predisposing factors of hypothermia is trauma (1, 2, 6, 26, 27). It was reported that there were trauma findings in the 75% of fatal hypothermia cases in the study of Lim and Duflou (28), 20.1% in the study of Elbaz et al (5), and 4% in the study of Brandstrom et al (9). We found 16 cases (37.2%) with trauma at autopsy.

Turk et al found that rectal temperature is an important diagnostic tool for establishing the diagnosis of fatal hypothermia despite the presence of information about “the significantly limitation of the usefulness of rectal temperature determination for the estimation of the time since death is very limited due expecting of dropping in rectal temperature in surviving individuals” in literature (29). Here, most cases died outdoors, and rectal temperature was not recorded. One postmortem finding is that hypothermia related-deaths were defined by common bright pink or red lividity similar the lividity of carbon-monoxide or cyanide due to binding to hemoglobin oxygen antemortem and preventing the passage to poor tissue (13, 25, 29, 30). This finding was seen in 33 cases (76.7%). Frostbite may be seen on the peripheries in individuals who are exposed to sub-zero temperatures in dry conditions (6, 27). Cold (frost) erythema was another autopsy finding in hypothermia related-deaths (9, 13, 25, 27, 28, 30). In 36 cases studied by Hejna et al the rate of cold erythema was 80% (16). This rate was 60.5% in our study.

Endocrine diseases including hypothyroidism, hyperglycemia and hypoaldosteronism are possible risk factors for hypothermia (5). Hypothyroidism especially is a major reasons for hypothermia in elderly women (25, 27). We found myxedema in one resident girl who died outdoors and was 17 years old.

Paradoxic undressing and the ‘hide and die’ syndrome involves undressing and hiding in small places such as pantries or wardrobes. This is a special case seen in some cases of hypothermia (2, 25-29). The rate of paradoxic undressing was defined between 20% and 30% in various articles (7, 9, 10, 28, 29). We did not note this or “hide and die syndrome” as in other studies (15, 16, 18). Hemorrhages of the synovial membrane and bloody discoloration of the synovial fluid are named as “inner knee signs” (16, 25, 26, 30), and were defined in all hypothermia cases studied by Hejna et al.
Hypothermia Deaths

This finding was found in 11 (84.6%) of the 13 cases. We think that it is one of the most valuable findings for positive identification of hypothermia.

Hemorrhagic spots of the gastric mucosa are known as Wischnewski spots or Wischnewski ulcers and are one of the lesions commonly described in autopsy findings of hypothermia related-deaths (3, 7, 16, 26). Similar ulcers were described in the ileum and colon (25). The possible reasons for these lesions were defined as mucosal hypoxia due to declining metabolic rates due to cold as well as peripheral and splanchnic vasoconstriction associated with stress and a leftward shift of the oxyhemoglobin dissociation curve (2, 4). In an animal study, Wischnewski spots did not occur in Sprague-Dawley rats who died of hypothermia under anesthesia. Researchers suggested that stress may be a significant effect modifier in the development of Wischnewski spots in lethal hypothermia (32). The incidence of Wischnewski spots (and/or ulcers) was 43.5% (7), 65.7% by Brandstrom et al (9), 66.7% by Dogan et al (15), 79% by Lim and Duflo (28), 83% by Henja et al (16), 92% and 100% by Bright et al (10). We found the rate of Wischnewski spots to be 74.4% in accordance with the literature. We think that Wischnewski spots are useful for positive identification.

In the literature, some nonspecific findings of hypothermia-related deaths (hemorrhage in the psoas muscle, pectoralis minor muscle and first intercostal muscle; dilatations of the right atrium and ventricle of heart; acute heart failure; focal myocardial degeneration and necrosis of the heart muscle; differences in the left and right heart blood color; dilatation of the right atrium and ventricle; hemorrhage, congestion and/or edema in the lungs; bronchopneumonia; congestion of the vena cava; congestion of the liver and/or spleen; acute tubular necrosis; lipid deposits in the glomeruli, liver, heart and skeletal muscle, etc.) were reported (15, 25, 26, 30). Enzymatic fat necrosis of the pancreas or pancreatitis is another finding in some autopsies of hypothermia-related deaths (15, 25, 26, 30). But this finding is controversial due to hemorrhages into the pancreas and possible autolysis along with pre-existing conditions such as alcohol (26, 28, 33). In this study, we found hemorrhage, congestion and/or edema in the lungs in 22 (51.2%) cases, enzymatic fat necrosis of the pancreas in 7 cases (16.3%), and congestion of liver and/or spleen in 20 cases (46.5%). Other nonspecific findings
was not defined in any of autopsy reports.

Psychiatric disorders such as schizophrenia, substance abuse, and personality disorders are important risk factors for fatal or non-hypothermia and the rate of psychiatric disorders in hypothermia was defined between 6.3% and 36.7 in various studies (5, 9, 18, 28, 30, 34). We did not evaluate cases for psychiatric illness because the majority of cases were foreign nationals who lacked medical history.

Drug and alcohol abuse are predisposing factors (2, 6). Alcohol is the most common intoxicant associated with hypothermia because of its ability to cause cutaneous vasodilation, impairment of shivering, and impairment of adaptive behavior (6). Leikin et al was reported that more than 150 drugs are also predisposing factors for hypothermia (6). In various studies, the rate of alcohol in blood in hypothermia cases is between 11.6% and 63.7% (9, 10, 16, 18, 22). We found antemortem alcohol intake in only one case who died in prefabricated container, but no drugs. This is probably because these persons are from Muslim majority countries such as Turkey, Afghanistan, Iraq and Syria (35).

Due to the lack of post-mortem immunohistochemistry and biochemistry laboratories in Turkey, laboratory tests that define hypothermia such as ubiquitin, hippocampal microtubule-associated protein 2 (MAP2), calcium and sodium, chromogranin A and adrenocorticotropic hormone (25) were not studied and are a limitation of this study.

**CONCLUSION**

Illegal refugees are an important social problem in Turkey. Hypothermia should be considered as a cause of death for refugees when they are found in the cold provinces.

The difficulty of the autopsy diagnosis of fatal hypothermia and relatively nonspecificity of morphological findings are important problems for forensic pathologists and other death investigators. In this study, we submitted one of the largest series of autopsy findings ever for hypothermia-related deaths. We noted bloody discoloration of the synovial fluid—this is the most valuable finding for
positive identification of hypothermia and was previously reported in a few articles. Finally, we found that Wischnewski spots still have value for positive identification.

AUTHORS’ NOTE

Y Hekimoglu conceived paper, oversaw data collection, conducted data analysis, wrote manuscript and approved final version. Y Etli participated in study design and interpretation of data; critically revised manuscript and approved final version. O Gumus participated in study design and interpretation of data, critically revised manuscript and approved final version. E Kartal participated in study design, interpretation of data and revision of manuscript and approved final version. U Demir participated in study design, data analysis, and interpretation of data and revision of manuscript and approved final version. M Asirdizer provided oversight to study, participated in study design, data analysis and interpretation, critically revised manuscript and approved final version. The authors declare that they have no conflicts of interest.
REFERENCES


10. Turkish State Meterological Service MGM [Internet]. Ankara, IL: Official Statistics (Statistical Data of Our Provinces)-Van (Turkish web pages); [rev 1 Nov 2015; cited 7 Nov
Hypothermia Deaths


### Table 1: The highest and the lowest temperatures according to months in Van Province between 1950 and 2014 (Turkish State Meteorological Service14)

<table>
<thead>
<tr>
<th>Months</th>
<th>Mean Temperature (°C)*</th>
<th>Lowest Temperature (°C)</th>
<th>Mean of Lowest Temperature (°C)</th>
<th>Highest Temperature (°C)</th>
<th>Mean of Highest Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>-3.5</td>
<td>-28.7</td>
<td>-7.7</td>
<td>12.6</td>
<td>1.8</td>
</tr>
<tr>
<td>February</td>
<td>-2.9</td>
<td>-28.2</td>
<td>-7.2</td>
<td>14.3</td>
<td>2.5</td>
</tr>
<tr>
<td>March</td>
<td>1.4</td>
<td>-22.7</td>
<td>-2.8</td>
<td>22.7</td>
<td>6.6</td>
</tr>
<tr>
<td>April</td>
<td>7.8</td>
<td>-17.5</td>
<td>2.8</td>
<td>27.2</td>
<td>12.9</td>
</tr>
<tr>
<td>May</td>
<td>13.1</td>
<td>-1.5</td>
<td>7.0</td>
<td>28.3</td>
<td>18.3</td>
</tr>
<tr>
<td>June</td>
<td>18.1</td>
<td>-2.6</td>
<td>10.8</td>
<td>33.2</td>
<td>23.8</td>
</tr>
<tr>
<td>July</td>
<td>22.2</td>
<td>3.6</td>
<td>14.6</td>
<td>37.5</td>
<td>28.0</td>
</tr>
<tr>
<td>August</td>
<td>21.8</td>
<td>6.6</td>
<td>14.6</td>
<td>36.7</td>
<td>28.2</td>
</tr>
<tr>
<td>September</td>
<td>17.2</td>
<td>-0.1</td>
<td>10.8</td>
<td>35.0</td>
<td>24.1</td>
</tr>
<tr>
<td>October</td>
<td>10.7</td>
<td>-7.5</td>
<td>5.7</td>
<td>28.8</td>
<td>17.2</td>
</tr>
<tr>
<td>November</td>
<td>4.3</td>
<td>-20.5</td>
<td>0.2</td>
<td>20.1</td>
<td>10.0</td>
</tr>
<tr>
<td>December</td>
<td>-0.8</td>
<td>-21.3</td>
<td>-4.6</td>
<td>15.5</td>
<td>4.4</td>
</tr>
</tbody>
</table>

### Table 2: The distribution of cases according to age groups and genders

<table>
<thead>
<tr>
<th>Age Groups</th>
<th>Males (n=36)</th>
<th>%</th>
<th>Females (n=7)</th>
<th>%</th>
<th>Total (n=43)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-10</td>
<td>7</td>
<td>19.4</td>
<td>3</td>
<td>42.9</td>
<td>10</td>
<td>23.3</td>
</tr>
<tr>
<td>11-20</td>
<td>5</td>
<td>13.9</td>
<td>1</td>
<td>14.2</td>
<td>6</td>
<td>13.9</td>
</tr>
<tr>
<td>21-30</td>
<td>20</td>
<td>55.6</td>
<td>3</td>
<td>42.9</td>
<td>23</td>
<td>53.5</td>
</tr>
<tr>
<td>31-40</td>
<td>3</td>
<td>8.3</td>
<td>0</td>
<td>0.0</td>
<td>3</td>
<td>7.0</td>
</tr>
<tr>
<td>41 ≤</td>
<td>1</td>
<td>2.8</td>
<td>0</td>
<td>0.0</td>
<td>1</td>
<td>2.3</td>
</tr>
</tbody>
</table>
Table 3: The distribution of cases according to death scenes

<table>
<thead>
<tr>
<th>Death Scene</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mountainous Region Near Turkey-Iran Borderland</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valleys and Foothills</td>
<td>21</td>
<td>53.5</td>
</tr>
<tr>
<td>The Bottom of Cliff</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Plains and Pastures</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Rural Areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Edges of Rivers and Lakes</td>
<td>6</td>
<td>44.2</td>
</tr>
<tr>
<td>Roadsides</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Dumping Ground</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Indoor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prefabricate Container</td>
<td>1</td>
<td>2.3</td>
</tr>
</tbody>
</table>
Fig. 1: The distribution of cases according to season.

Fig. 2: Livor mortis in two cases of hypothermia related-death
Fig. 3: Cold erythema on the nose in a case of hypothermia related-death.

Fig. 4: Bloody discoloration in the synovial fluid in a case of hypothermia related-death.
Hypothermia Deaths

Fig. 5: Wischnewski spots in a case of hypothermia related-death.

Fig. 6: A) An Afghan refugee who died due to hypothermia in mountains in the border area. B) In a corpse of a person which died due to hypothermia in the mountains, postmortem defects formed by wild animals in the parts of the body not covered by the snow.