An Overview of Hydrogen Sulfide Suicides in Yamagata Prefecture, Japan

KEN ISEKI1,2,*, AKIKO OZAWA1,2, KEIKO SEINO2,3, REIKO OKUBO4, KENTARO YAMAZAKI5, KAORU GOTO5, CHOICHIRO TASE4

1 Department of Regional Emergency Medicine, Fukushima Medical University, Fukushima, Japan
2 Department of Emergency and Critical Care Medicine, Yamagata University School of Medicine, Yamagata, Japan
3 Department of Anatomy and Cell Biology, Yamagata University School of Medicine, Yamagata, Japan
4 Department of Emergency and Critical Care Medicine, Fukushima Medical University, School of Medicine, Fukushima, Japan
5 Department of Forensic Medicine, Yamagata University School of Medicine, Yamagata, Japan

Abstract

Background: Hydrogen sulfide (H₂S) is one of the major toxic gases and the second most common cause of death in workplaces among toxic gas-related morbidities. H₂S suicides using hospital-based data were studied in 2008. However, most cases did not involve ambulance transfer to the hospital because the victims of H₂S suicide were usually found dead at the scene. H₂S-suicide-related data elucidating an overview of the patients were therefore not available. To clarify the mechanism of poisoning, H₂S suicide victim data were obtained from the Yamagata prefectural police office.

Methods: H₂S suicide data from the Yamagata prefectural police office for the period 2007 to 2013 were obtained. All H₂S suicide-related data in Yamagata Prefecture were collected, including sex, age, location of suicide, source of hydrogen sulfide, and methods

Results: In this study, a total of 41 cases (29 men and 12 women) were included for analysis. The number of H₂S suicides reached a peak in April 2008, with 14 cases being reported, followed by 10 in 2009, 10 in 2010, 3 in 2011, and 4 in 2012. The mean age of the victims was 31.8 ± 12.2 years (range: 18–77 years), and the median age was 28 years. Sources of H₂S gas included cars (23 cases; 54%), rooms (8 cases; 20%), and bathrooms (5 cases; 12%). We also identified several cases of a novel suicide method, wherein H₂S was generated in a plastic garbage bag that the victim would then place over their head or body into the bag.

Conclusion: Most cases of H₂S poisoning are not registered at hospital, therefore, the data on these victims need to be analyzed from police office data. H₂S-related suicides are known to occur in confined places including cars or toilets; however a new form of H₂S suicide using a sealed plastic bag is increasingly prevalent, possibly due to widespread sharing of this method on the internet.

Keywords: Hydrogen Sulfide; Japan; Poisoning; Police; Suicide

A novel suicide method using H₂S generation has been described since 2007 in Japan; this method involved; mixing hydrochloric acid detergent and sulfur-based additive or pesticide (3-10). A total of 19 suicides by H₂S poisoning were reported in 2007; however there was a remarkable increased to 1056 cases in 2008 (7,8). H₂S suicides using hospital-based data were studied in 2008 (4). However, most cases were not transferred to the hospital because the H₂S victims were usually pronounced dead at the scene. Therefore, the previous report using hospital-based data might have been insufficient with regard to certain aspects of H₂S poisoning.

Japan has had a major public health problem with suicide, with a suicide rate of 24.0 per 100,000 people in 2010 (11). These rates tend to be particularly higher in northern Japan, especially in areas along the Sea of Japan, including prefectures such as Aomori, Akita, Yamagata and Niigata. Yamagata Prefecture is located in the north east of Japan and has a population of about 1,000,000 (12). The suicide rate in
Hydrogen Sulfide Suicide Overview in Yamagata prefecture
K. Iseki et al.

Yamagata prefecture was higher 28.8 per 100,000 people in 2010 significantly higher than the national average (11). The goal of this study is to reassess the phenomenon of fatal H$_2$S-related suicides in Yamagata Prefecture using police-based data.

**METHODS**

H$_2$S suicide data from the Yamagata prefectural police office from 2007 to 2013 were obtained. All H$_2$S suicide-related data in Yamagata Prefecture were collected, including sex, age, location of suicide, source of hydrogen sulfide (H$_2$S), and methods of suicide. The data were analyzed by using Microsoft Office Excel® 2013 (Microsoft Corp., Redmond, WA, USA). The data on age are shown as mean (SD).

**RESULTS**

Data from a total of 41 cases (29 men and 12 women) were submitted for analysis (Figure 1). The mean age of the victims was 31.8±12.2 years (range: 18–77 years), and the median age was 28 years. The victims, male and female and were mostly between the ages of 20-29.

The first of such cases in Yamagata Prefecture was reported on April 9, 2008, and reached a peak (14 cases) in 2008, followed by 10 cases in 2009, 10 cases in 2010, 3 cases in 2011, and 4 cases in 2012 (Table 1). H$_2$S gas was generated by mixing hydrochloric acid detergent with either sulfur-based bath additive (MUTOHAP®) (used in 9 cases, 22%), or a sulfur-based pesticide (used in 30 cases, 73%) (Table 1).

The locations where the suicides took place were as follows; car (23 cases, 56%), household room (8 cases, 20%), and bathroom (5 cases, 12%) (Table 2). There were 10 cases (24%) where the suicide method involved a sealed plastic bag. In those cases, H$_2$S gas was generated in the sealed plastic bag, then the victims inserted their head or body into the bag. This suicide method was used in the following places: household room (5/8 cases), car (3/23 cases), bathroom (1/5 cases), and road (1/1 case) (Table 2).

**DISCUSSION**

In Japan, although the total number of H$_2$S suicides is declining, it still remains significantly high. Furthermore, the methods of H$_2$S generation have been spread worldwide and a number of H$_2$S suicides have been reported in the United States (2,13-15), England and Wales (16), and Australia (17). In the United States, the numbers of H$_2$S suicide cases were 2 in 2008, 10 in 2009, and 18 in 2010 (13). The age distribution of the present study is similar to that of the hospital-based study in the previous report as well as other reports in Japan (4,5,13). In Japan, the total number of annual suicides is estimated to be over 30,000 (18). The gender ratio (male/female) was 2.7 among all the victims in 2009 and

**Table 1. The generation source of hydrogen sulfide**

<table>
<thead>
<tr>
<th>Year</th>
<th>Suicide</th>
<th>Sulfur-based bath additive</th>
<th>Sulfur-based pesticide</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>MUTOHAP®</td>
<td>Lime sulfur</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>14</td>
<td>7</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>2009</td>
<td>10</td>
<td>0</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>2010</td>
<td>10</td>
<td>1</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>2011</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>2012</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>2008-2012</td>
<td>41</td>
<td>9</td>
<td>30</td>
<td>2</td>
</tr>
</tbody>
</table>

**Table 2. Location of hydrogen sulfide gas generation in suicide group**

<table>
<thead>
<tr>
<th>Location</th>
<th>n (%)</th>
<th>Plastic garbage bag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>23 (56)</td>
<td>3</td>
</tr>
<tr>
<td>Household room</td>
<td>8 (20)</td>
<td>5</td>
</tr>
<tr>
<td>Bathroom</td>
<td>5 (12)</td>
<td>1</td>
</tr>
<tr>
<td>Shed</td>
<td>2 (4.8)</td>
<td>0</td>
</tr>
<tr>
<td>Lavatory</td>
<td>1 (2.4)</td>
<td>0</td>
</tr>
<tr>
<td>Toilet</td>
<td>1 (2.4)</td>
<td>0</td>
</tr>
<tr>
<td>Road</td>
<td>1 (2.4)</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>41 (100)</td>
<td>10</td>
</tr>
</tbody>
</table>
Table 3. The comparison of H₂S suicide locations between police-based data and hospital-based data

<table>
<thead>
<tr>
<th>Location</th>
<th>Police-based data in Yamagata</th>
<th>Hospital-based data in Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Present study</td>
<td>Kamijo et al.</td>
</tr>
<tr>
<td>Car</td>
<td>56%</td>
<td>18%</td>
</tr>
<tr>
<td>Room</td>
<td>20%</td>
<td>23%</td>
</tr>
<tr>
<td>Bathroom/toilet</td>
<td>14%</td>
<td>45%</td>
</tr>
<tr>
<td>Other</td>
<td>10%</td>
<td>14%</td>
</tr>
</tbody>
</table>

2.23 among victims aged 20 to 29 years (19). Two peaks in suicide rate were seen among men, i.e., middle aged (50–59 years) and elderly (> 80 years), whereas the rate among women gradually increases with age (20). Acute poisoning is the second most frequently reported methods of suicide among people aged 20 to 29 years in Japan (19,21). In the present study, there are twice as many as male victims as there are female victims, which is similar to the gender ratio of total Japanese suicides in the same time period.

Generally, H₂S suicide occurs in confined space, such as a small room, toilet or car, where the high concentrations of the toxic gas can be inhaled (Table 3) (4,5). In this study using Yamagata Prefecture’s police office data, more than 50 percent of H₂S suicides were performed in the car (Table 2). Similar trends are shown in the H₂S suicides data in the United States (80%, 24/30 cases). On the other hand, autopsy data in Tokyo shows that most victims were found in household rooms. The reason for this difference may be ascribed to the different life styles between Yamagata (rural area) and Tokyo (a big city). Tokyo residents, especially those in their twenties, do not usually own a car due to efficient public transport facilities. In rural regions, cars are the main means of transportation, as is the case in the United States.

Detailed investigation of the suicides that took place in the household rooms revealed that the victims produced H₂S gas in a sealed plastic bag. In this study, 24% (10/41 cases) of the victim used a sealed plastic bag. Also, the autopsy data in Tokyo showed that 24% (4/17 cases) had used the same method (10). Interestingly, this method of using a plastic bag is also described in cases of helium poisoning (22-25). It has been reported that suicides using helium gas are increasing in San Diego (USA), England and Wales, and Australia, presumably because it is easy to purchase a helium tank online and the method of suicide may be easily accessible via websites (14,16,22). The form of suicide using H₂S gas generated in the sealed bag may have been adapted from helium poisoning (23). In Japan, since these websites had their access restricted, the number of such suicides decreased.

Taken together, to understand the cause of acute poisoning, it is important to analyze not only hospital-based data, but also police-based data, as each source contains different detailed information.

LIMITATIONS

H₂S poisoning was diagnosed by the situation at the scene of the suicide and the concentration of sulfide and thiosulfate in blood and urine were not measured.

CONCLUSION

The previous analysis of H₂S suicides in 2008 used hospital-based data, which revealed that acute poisoning were most frequently occurred in a room. In the present study using police office-based data, it was found that H₂S victims were mainly found in cars.

ACKNOWLEDGEMENT

The authors would like to thank the staff at Yamagata prefectoral police office which contributed data to this study.

Conflict of interest: None to be declared.

Funding and support: None.

REFERENCES

10. Maebashi K, Iwadate K, Sakai K, Takatsu A, Fukui K, Aoyagi M et al. Toxicological analysis of 17 autopsy cases of hydrogen...


