

## ORIGINAL ARTICLE

# An Overview of Hydrogen Sulfide Suicides in Yamagata Prefecture, Japan

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## Abstract

**Background:** Hydrogen sulfide (H<sub>2</sub>S) is one of the major toxic gases and the second most common cause of death in workplaces among toxic gas-related morbidities. H<sub>2</sub>S suicides using hospital-based data were studied in 2008. However, most cases did not involve ambulance transfer to the hospital because the victims of H<sub>2</sub>S suicide were usually found dead at the scene. H<sub>2</sub>S suicide-related data elucidating an overview of the patients were therefore not available. To clarify the mechanism of poisoning, H<sub>2</sub>S suicide victim data were obtained from the Yamagata prefectural police office.

**Methods:** H<sub>2</sub>S suicide data from the Yamagata prefectural police office for the period 2007 to 2013 were obtained. All H<sub>2</sub>S 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 H<sub>2</sub>S 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 H<sub>2</sub>S 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 H<sub>2</sub>S 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 H<sub>2</sub>S poisoning are not registered at hospital, therefore, the data on these victims need to be analyzed from police office data. H<sub>2</sub>S-related suicides are known to occur in confined places including cars or toilets; however a new form of H<sub>2</sub>S 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

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## INTRODUCTION

Hydrogen sulfide (H<sub>2</sub>S) is one of the major toxic gases and the second most common cause of death in workplaces among toxic gas-related morbidities (1). It is a colorless, inflammable gas with a characteristic odor of rotten eggs. It exists as a natural gas, volcanic gas, and is found in sulfur hot springs, in industrial waste in sewers, barns, commercial fishing holds, ships' holds, and oil wells (1). Acute intoxication occurs upon exposure of H<sub>2</sub>S in natural or occupational accidents (1).

H<sub>2</sub>S inhibits cytochrome oxidase and leads to inhibition of aerobic cellular respiration. Inhalation of a low H<sub>2</sub>S concentration causes eye and respiratory irritation, headache, dizziness, and pulmonary edema (1-3). High concentration (≥1000 ppm) of H<sub>2</sub>S leads to immediate unconsciousness and cardiopulmonary arrest. Thus, H<sub>2</sub>S is commonly referred to as "knockdown gas" (1).

A novel suicide method using H<sub>2</sub>S 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 H<sub>2</sub>S poisoning were reported in 2007; however there was a remarkable increased to 1056 cases in 2008 (7,8). H<sub>2</sub>S suicides using hospital-based data were studied in 2008 (4). However, most cases were not transferred to the hospital because the H<sub>2</sub>S 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 H<sub>2</sub>S 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

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

Year	Suicide	Sulfur-based bath additive MUTOHAP®	Sulfur-based pesticide Lime sulfur	Unknown
2008	14	7	7	0
2009	10	0	8	2
2010	10	1	9	0
2011	3	0	3	0
2012	4	1	3	0
2008-2012	41	9	30	2

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<sub>2</sub>S-related suicides in Yamagata Prefecture using police-based data.

### METHODS

H<sub>2</sub>S suicide data from the Yamagata prefectural police office from 2007 to 2013 were obtained. All H<sub>2</sub>S suicide-related data in Yamagata Prefecture were collected, including sex, age, location of suicide, source of hydrogen sulfide (H<sub>2</sub>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 the number of H<sub>2</sub>S suicides

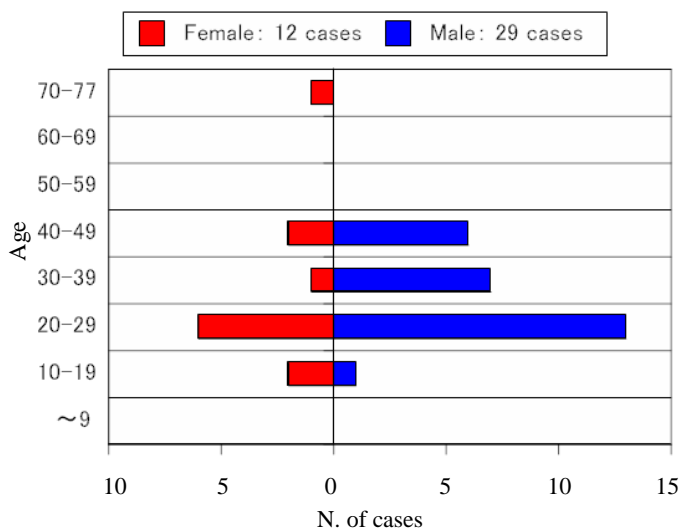
reached a peak (14 cases) in 2008, followed by 10 cases in 2009, 10 cases in 2010, 3 cases in 2011, and 4 cases in 2012 (Table 1). H<sub>2</sub>S gas was generated by mixing hydrochloric acid detergent with either sulfur-based bath additive (MUTOHAP®) (used in 9 cases, 22%), or a sulfur-based pesticide (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<sub>2</sub>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<sub>2</sub>S suicides is declining, it still remains significantly high. Furthermore, the methods of H<sub>2</sub>S generation have been spread worldwide and a number of H<sub>2</sub>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<sub>2</sub>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



**Figure 1** Demographic features of the hydrogen sulfide suicide group

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

Location; n (%)	Plastic garbage bag
Car 23 (56)	3
Household room 8 (20)	5
Bathroom 5 (12)	1
Shed 2 (4.8)	0
Lavatory 1 (2.4)	0
Toilet 1 (2.4)	0
Road 1 (2.4)	1
<b>Total 41 (100)</b>	<b>10</b>

**Table 3.** The comparison of H<sub>2</sub>S suicide locations between police-based data and hospital-based data

Location	Police-based data in Yamagata	Hospital-based data in Japan	
	Present study	Kamijo et al.	Iseki et al.
Car	56%	18%	20%
Room	20%	23%	17%
Bathroom/toilet	14%	45%	55%
Other	10%	14%	8%

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, H<sub>2</sub>S 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 H<sub>2</sub>S suicides were performed in the car (Table 2). Similar trends are shown in the H<sub>2</sub>S suicides data in the United States (80%, 24/30cases). 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 H<sub>2</sub>S gas in a sealed plastic bag. In this study, 24% (10/41cases) of the victim used a sealed plastic bag. Also, the autopsy data in Tokyo showed that 24% (4/17cases) 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 H<sub>2</sub>S 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

H<sub>2</sub>S 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 H<sub>2</sub>S 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 H<sub>2</sub>S victims were mainly found in cars.

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