Results of Recognition Tests on Japanese Subjects of the Labels Presently Used in Japan and the UN-GHS Labels

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Abstract: Results of Recognition Tests on Japanese Subjects of the Labels Presently Used in Japan and the UN-GHS Labels: Kunio Hara, et al. Department of Environmental Medicine, School of Medicine, Kurume University—The UN-GHS, a globally harmonized system of classifying and labeling chemicals that was recommended by the United Nations in 2003, will be implemented globally in 2008. This system is expected to encourage people to behave in a way that reduces the risk of accidents or diseases caused by chemicals. However, the UN-GHS differs significantly from the present Japanese system of classifying and labeling chemicals. In particular, since the Japanese system does not require pictographic labels, ordinary Japanese people are not familiar with the new pictographic labels defined in the UN-GHS. Hence, before introducing the UN-GHS at the Japanese workplace, it is critical to clarify the actual usage conditions and the problems that this labeling system of hazardous chemicals poses, and to manage the related problems. We conducted recognition tests on Japanese subjects of the labels presently used in Japan and the UN-GHS labels. The results revealed that the subjects faced some difficulty in recognizing the meanings of some UN-GHS labels. The percentage of questions that were answered correctly with regard to the labels depicting ‘cylinder,’ ‘corrosion,’ ‘health hazard,’ and ‘aqueous hazard,’ with no accompanying explanatory statements, was less than 60. The results of the answers regarding the labels depicting ‘flame’ and ‘flame over circle’ revealed that many subjects were unable to distinguish one from the other. Further, many subjects were unable to clearly distinguish ‘skull and crossbones’ from ‘health hazard.’ These results indicate that it is very important to impart correct education regarding these labels.

Key words: GHS, Chemical risk management, Hazard communication, Label, SDS, Chemical hazard, Pictogram

In contemporary society, ordinary people have to occasionally handle certain hazardous chemicals that require special techniques and experience as each hazardous chemical has its own potential hazard. In such cases, it is essential for ordinary people to be informed of the chemical hazards in a comprehensible manner and to behave in a way that helps them to avoid accidents, diseases, and environmental pollution caused by these hazardous chemicals. In 2003, the United Nations recommended a “globally harmonized system of classification and labeling of chemicals” (UN-GHS) as a hazard communication tool. UN-GHS was scheduled to be implemented in 2006 by the countries attending the 12th APEC Economic Leader’s Meeting, 2004¹, and will be implemented globally in 2008²–⁵. UN-GHS requires the same system of classifying and labeling (labels and Safety Data Sheets (SDS)) of hazardous chemicals around the world.

In December 2006, amendments to the Occupational Health and Safety Law of Japan were implemented; thus, UN-GHS was introduced to the Japanese workplace. However, UN-GHS differs significantly from the previous Japanese system of classifying and labeling hazardous chemicals⁶. In particular, the previous Japanese system did not require pictographic labels, and ordinary Japanese people are not familiar with the new pictographic labels defined in UN-GHS. Hence, before introducing UN-GHS to the Japanese workplace, it was critical to clarify the actual usage conditions and the problems that the UN-GHS system of labeling hazardous chemicals poses, and
to manage the related problems. Suppliers and individuals in charge at manufacturing companies are mainly involved in the classification of hazardous chemicals. Furthermore, regulatory agents have been establishing databases for the UN-GHS classification of hazardous chemicals and software for classifying mixtures regulated by the laws of Japan. With regard to understanding labels and SDS, although the regulatory agents have been providing model labels and SDS of hazardous chemicals regulated by Japanese laws, it seems very difficult for ordinary people to understand the UN-GHS labels without education because there are many different but similar labels that are not related to chemical risk management in daily life.

The objective of this study was to clarify the recognition levels of the labels presently used in Japan and the UN-GHS labels by conducting recognition tests with Japanese subjects.

Methods

Recognition test of the labels presently used in Japan with Japanese subjects

The Japanese laws for chemical risk management regulating labeling (labels and/or SDS) of hazardous chemicals are at present the Occupational Health and Safety Law, the Poisonous and Deleterious Substances Control Law, the Chemical Substance Releases Reporting and Management Promotion Law (PRTR Law), the Fire Service Law, the High Pressure Gas Safety Law, and many other laws. These laws prescribe labels with written Japanese characters on them. There were no Japanese laws regulating pictographic labels on products in 2005.

Before conducting this study, we sent questionnaires regarding the labeling of hazardous chemicals to more than 200 Japanese chemical companies. We received responses from only 46 companies. We asked these companies to accept a survey of chemical risk management at the workplace. Eight companies (all manufacturing companies; 1 company: 50–99 employees, 2 companies: 100–299, 1 company: 500–999, 4 companies: 1,000 and above) cooperated and consented to the survey and recognition test of the labels presently used in Japan with Japanese subjects.

We conducted the 10-min test shown in Fig. 1 on the group leaders and workers of these eight companies after obtaining their informed consent. We requested them to write their responses in the blank squares next to the text boxes or pictograms. We asked them to specify their age, sex, the relation between their present occupation and chemicals, their history of attendance of chemistry lectures at high school and college, and their interest toward labels in daily life at the back of the test paper. We collected the test papers from the subjects who agreed to publication of the results. The labels tested were those that are currently regulated by Japanese laws and pictograms recommended by the Japan Crop Protection Association.

We evaluated the test results and assigned 0, 50, and 100 points to the answers after comparing them to the meaning intended by the laws according to the rating and coding of responses defined in Annex 6 of the “Globally Harmonized System of Classification and Labelling of Chemicals (GHS).” In this evaluation, a score of 0 indicates that the response is incorrect: the meaning provided is either completely wrong or has a very poor relation with meaning intended by the law. A score of 50 indicates that the response is partly correct: although some element of the meaning is correct, it would be insufficient to ensure adequate safety action or precaution. A score of 100 indicates that the response is correct: the meaning is identical or fully consistent with the meaning intended by the law. We used StatView software for statistical analysis.

Recognition test of the UN-GHS labels with Japanese subjects

Pure chemical substances and mixtures of chemical substances are classified into 27 hazards and further categorized into approximately 80 categories depending on the criteria defined by UN-GHS. UN-GHS defines nine pictograms that are used for approximately 70 categories. A UN-GHS label includes a combination of a pictogram, a signal word, a hazard statement, and precautionary statements with information regarding the chemical and the manufacturer or supplier. UN-GHS defines a comprehensibility testing methodology of the labels and SDSs in Annex 6 of GHS. However the time taken for the test is more than three hours.

We developed the following four types of test papers: (1) pictogram, (2) pictogram with a signal word, (3) pictogram with a signal word and a hazard statement, and (4) pictogram with a signal word, a hazard statement, and precautionary statements. As an example of one of the test papers, Fig. 2 shows (4) a pictogram with a signal word, a hazard statement, and precautionary statements including examples of answers in blank squares.

After obtaining informed consent, we conducted the tests, one of which is presented in Fig. 2, on subjects who had attended seminars or our lectures related to chemical risk management or UN-GHS. We administered one of the four types of tests randomly to each subject each time. We requested them to write their responses in the blank squares next to the pictograms. We asked them to specify their age, sex, occupation, the relation between their present occupation and chemicals, their history of attendance of chemistry lectures in high school and college, and their interest toward labels in daily life at the back of the test paper. We collected the test papers from the subjects who agreed to publication of the results.
We evaluated the test results and assigned 0, 50, and 100 points to the answers after comparing them to the meaning intended by GHS in the pictograms (Table 1) according to the rating and coding of responses defined in Annex 6 of GHS. In this evaluation, a score of 0 indicates that the response is incorrect: the meaning provided is either completely wrong or has a very poor relation with the meaning intended by GHS. A score of 50 indicates that the response is partly correct: although some element of the meaning is correct, it would be insufficient to ensure adequate safety action or precaution. A score of 100 indicates that the response is correct: the meaning is identical or fully consistent with the meaning intended by the GHS construct. (This includes responses that are not exactly the same as the meaning intended by the GHS but would suffice as the basis for a safety action or precaution.) We used StatView software for statistical analysis. The other things related to the test method are
**Results**

*Recognition test of the present labels used in Japan with Japanese subjects*

We obtained 53 (age: 40.5 ± 11.2, two females) answers from the subjects employed in the eight companies. Figure 3 shows the scores as percentages of questions answered correctly for the labels. The label numbers (<1>, <2>, <3>, <4>, <5>, <6>, <7>, <8>, <9>, and <10>) in Fig. 3 correspond to those in Fig. 1. The percentage of questions answered correctly for the labels regulated by Japanese chemical risk management laws was less than 60. However, the percentage of questions answered correctly for the labels recommended by the Japan Crop Protection Association was more than 80.

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**Table:**

<table>
<thead>
<tr>
<th>Label Number</th>
<th>Description</th>
<th>Meaning of the left-hand pictogram</th>
<th>Meaning of the left-hand pictogram</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1&gt;</td>
<td>Explosive: mass explosion hazard. Keep away from ignition sources.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;2&gt;</td>
<td>Extremely flammable gas. Keep away from ignition sources.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;3&gt;</td>
<td>May cause or intensify fire; oxidizer. Keep away from combustible materials.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;4&gt;</td>
<td>Contains gas under pressure; may explode if heated. Store in well-ventilated place.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;5&gt;</td>
<td>Causes serious eye damage. Wear eye/face protection.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;6&gt;</td>
<td>Toxic if inhaled. If inhaled, call a doctor.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;7&gt;</td>
<td>May cause allergy or asthma symptoms or breathing difficulties if inhaled. Avoid breathing gas.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;8&gt;</td>
<td>Causes serious eye irritation. If in eyes: rinse cautiously with water for several minutes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;9&gt;</td>
<td>Very toxic to aquatic life. Collect spillage.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 2.** A recognition test paper of the UN-GHS labels (written originally in Japanese).
There were many respondents who stated that they had no knowledge about the labels made with Japanese words on them. In addition, there were respondents who stated that they could easily guess the meanings of the pictograms without any prior knowledge and experience. This result revealed that pictographic labels are effective tools of communication as compared to text labels.

**Recognition test of the UN-GHS labels with Japanese subjects**

We obtained 204 responses (age: 37.8 ± 19.3, male/female=1.95/1.00). The study involved a total of 81 students, 56 company workers, 9 researchers, 47 others (such as housewives, doctors, and retired employees) and 11 non-responders. Figure 4 shows the scores as the percentage of questions answered correctly for the nine UN-GHS labels. The label numbers (<1>, <2>, <3>, <4>, <5>, <6>, <7>, <8>, and <9>) in Fig. 4 correspond to those in Fig. 2. (1), (2), (3), and (4) pertain to the four

### Table 1. Examples of correct answers provided for the recognition tests of the UN-GHS labels

<table>
<thead>
<tr>
<th>Pictogram</th>
<th>Name</th>
<th>Behavior expected to reduce the risk of accidents or diseases. Characteristics of the hazards to remember.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Exploding bomb</td>
<td>Should handle carefully since this is an explosive chemical. May produce heat. Unstable.</td>
</tr>
<tr>
<td>2</td>
<td>Flame</td>
<td>Catches fire easily from ignition sources. Easy to burn. Keep away from ignition sources.</td>
</tr>
<tr>
<td>3</td>
<td>Flame over circle</td>
<td>Pyrophoric material. Oxidizer. Capable of igniting other combustible materials. Do not mix with other combustible materials.</td>
</tr>
<tr>
<td>4</td>
<td>Gas cylinder</td>
<td>Be cautious since this contains gas under pressure. May explode if heated or if exposed to shock.</td>
</tr>
<tr>
<td>5</td>
<td>Corrosion</td>
<td>Corrosive. May cause serious eye or skin damage. May cause eye irritation. Wear gloves. May be corrosive to metals.</td>
</tr>
<tr>
<td>6</td>
<td>Skull and crossbones</td>
<td>Acute toxicity. Fatal or toxic if swallowed, inhaled, or allowed contact with skin. Do not swallow.</td>
</tr>
<tr>
<td>8</td>
<td>Exclamation mark</td>
<td>Be cautious about toxic substances. Warning. Toxic or dangerous even though less toxic or less dangerous.</td>
</tr>
<tr>
<td>9</td>
<td>Environment</td>
<td>Hazardous to the aquatic environment. Environmental pollutants. Avoid release in the environment.</td>
</tr>
</tbody>
</table>

(written originally in Japanese)

![Fig. 3. A comparison of the recognition levels of the labels presently used in Japan. The label numbers (<1>, <2>, <3>, <4>, <5>, <6>, <7>, <8>, <9>, and <10>) correspond to those in Fig. 1.](image)
different types of labels explained above. The letter “n” in Fig. 4 denotes the number of subjects.

The percentage of questions answered correctly tended to increase in line with (1), (2), (3), and (4). This result reveals that written Japanese words on labels were an effective tool for information communication ($p < 0.01$, where $p$ denotes the $p$ value for a two-way repeated measure ANOVA with the scores of the (1) type test in comparison with those of the (2), (3), and (4) type tests among all the responses). The percentage of questions answered correctly for the labels depicting ‘cylinder,’ ‘corrosion,’ ‘health hazard,’ and ‘environment’ with no literal statements was less than 60; these labels were also difficult to understand when only the signal words were provided.

The results of the responses to the labels depicting ‘flame’ and ‘flame over circle’ revealed that many subjects could not distinguish one from the other. Many subjects seemed to interpret these labels as indicating flammable, but they could not understand the meaning of the label depicting ‘flame over circle’ as oxidizing chemicals.

The results of the responses to the labels depicting ‘skull and crossbones’ and ‘health hazard’ as acute lethal hazard and chronic hazard (except for specific target organ systemic toxicity-single exposure), respectively, revealed that many subjects could not strictly distinguish one label from the other. Many subjects seemed to interpret these labels as toxic at similar levels. Therefore, they could not understand that the label indicating ‘skull and crossbones’ implies short-term acute lethal toxicity and that the one indicating ‘health hazard’ implies long-term chronic toxicity (except for specific target organ systemic toxicity-single exposure).

Figures 5 and 6 illustrate the effects of the subjects’ present occupations ($p=0.046$, where $p$ denotes the $p$ value for a two-way factorial ANOVA with the scores of having a relation between present occupations and chemicals in comparison with those of not having a relation between present occupations and chemicals among all the responses) and their chemistry lectures at school ($p<0.01$, where $p$ represents the $p$ value for a two-way factorial ANOVA with the scores of attending chemical lectures at school in comparison with that of not attending chemical lectures at school among all the responses), respectively, on the recognition of the UN-GHS labels. According to these results, those who attended chemistry lectures at school and were currently employed in a company related to chemicals, showed a relatively high tendency to answer correctly. The age, sex, and label interest tendency toward the labels in daily life were not related to understanding of the meanings of the UN-GHS labels.

**Discussion**

Most subjects who were unaware of the pictographic labels recommended by the Japan Crop Protection
Association before the test responded correctly. This result suggests that pictographic labels are easy to understand and that using appropriate pictograms is effective at encouraging people to behave in a way that reduces the risk of accidents or diseases caused by hazardous chemicals. However, there was some difficulty in recognizing the meanings of some of the UN-GHS labels, such as the labels depicting ‘cylinder,’ ‘corrosion,’ ‘health hazard,’ and ‘environment’ with no accompanying textual statements. This result suggests that it is important to educate ordinary people regarding the four pictograms even though these pictographic labels with the accompanying statements were easy to understand.

Strictly speaking, many subjects could not distinguish the pictographic labels depicting ‘flame’ from ‘flame over circle’ and could not understand the labels depicting ‘skull and crossbones’ as acute lethal toxicity and ‘health hazard’ as chronic toxicity (except for specific target organ
systemic toxicity—single exposure) either. This result indicates that it is very important to correctly educate people about these labels.

Some of subjects of this study were people concerned with chemical risk management, group leaders at chemical manufacturing companies, and some were participants who had attended seminars or our lectures related to chemical risk management or UN-GHS. However, the method of subject selection does not negate our results and discussions, even though the number of subjects was very small and the results obtained in this study might have a positive bias. We anticipate that subjects would respond less correctly if they were less concerned with hazardous chemicals.

Although the amount of information increases in line with (1), (2), (3), and (4) in the recognition test of the UN-GHS labels, the percentage of questions answered correctly in the (3) condition was less than those in the (1) and (2) conditions in <8>, the ‘exclamation mark’ pictogram. Also, the percentage in the (2) condition was less than that in the (1) condition in the <9>, the ‘environment’ pictogram. The reasons for these results were unclear, but the limitation of the test time might be one of the reasons since blank squares were particularly evident for <8>, the ‘exclamation mark’ pictogram, and <9>, the ‘environment’ pictogram in some responses.

Based on the results obtained in this study, we recommend a new educational method for recognizing the UN-GHS labels as follows:

1) Implement a recognition test of the UN-GHS labels with no accompany textual statements.
2) Explain the UN-GHS labels based on the results of the people tested; educate people on the meanings of the ‘cylinder,’ ‘corrosion,’ ‘health hazard,’ and ‘environment’ pictograms; emphasize the difference between the ‘flame’ and the ‘flame over circle’ pictograms; and distinguish acute lethal toxicity from chronic toxicity.
3) Explain UN-GHS in detail.
4) Exchange questions and answers.

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