

education affected knowledge of genetics. Moreover, new educational guidelines from the Japanese Ministry of Education (2003) have deleted the topic of mutation from Biology Course 1 taken by many high school students. There is concern that lay people have impediments to understanding genetic diseases caused by mutation, which is a central point in genetic counseling. Moreover, it is essential to have knowledge regarding somatic mutation because cancers are often caused by somatic mutation. Knowledge regarding somatic mutation is very important when we consider genetic counseling for familial cancers.

Some studies assessing knowledge of genetics among lay people have revealed that knowledge of lay participants (14–16), patients (17) and their spouses (18) was limited. Moreover, even physicians, with the exception of geneticist (19, 20), had insufficient knowledge of genetics. Knowledge on genetics in physicians and lay people has become necessary because of the recent Human Genome Project as well as because of the discovery that genetic knowledge is helpful for human healthcare.

Factor structure of the three terms *mutation of gene*, *change of gene*, and *lesion of gene*

As the result of factor analysis, three factors were extracted for the three terms: Value Factor contained the general positive–negative concept, Change Rate Factor contained the static–dynamic concept and Intention Factor contained the accidental–intentional concept.

Results of two-way ANOVAs (Term \times Knowledge Group) suggested different impressions of the three Japanese terms for the concept of mutation: *mutation of gene*, *change of gene*, and *lesion of gene*. Firstly, *lesion of gene* in Japanese had the most negative impression without relation to knowledge on Value Factor. According to the Japanese dictionary (21), the term *lesion* has the meaning of (i) physical damage or psychological damage, (ii) breach, break, cleft, fissure, fracture or split line, (iii) fault or imperfection and (iv) abasement, shame or disgrace. The term *lesion* (in Japanese: *Kizu*) includes concepts relating to physical wounds and also mental trauma. It seems that the negative impression of the term *lesion of gene* depended on the fundamental negative impression of the term *lesion* (*Kizu*). Japanese healthcare professionals might think that it is easy for lay people to understand mutation by using the term *lesion of gene* during genetic counseling, or at a heredity

clinic, because *Kizu* is a familiar term for lay people. But using a negative term might lead to psychological distress for clients with anxiety and stress who are recipients of genetic counseling (22). Healthcare professionals giving genetic counseling to clients and working in heredity clinics should keep in mind that clients and patients might have a negative impression of the term *lesion of gene* regardless of their knowledge. The Japanese term for *change of gene* resulted in the most positive impression without relation to knowledge on Value Factor, probably because the term *change* has a neutral impression.

Secondly, an interaction between Term and Knowledge was observed on Change Rate Factor such that the low-knowledge group had a lower impression of *sudden*, *fast*, and *changing* with *mutation of gene* on Change Rate Factor because *Totsuzen*, in the Japanese term for *mutation* (*Totsuzen-Hen'i*), means sudden. Japanese high school biology textbooks teach about the concept of mutation (*Hen'i*) by using *Kankyo-Hen'i* (environmental variation) and *Totsuzen-Hen'i* (gene mutation and chromosomal mutation), so it appears that middle- and high-knowledge groups had an impression of the term *Hen'i* that included sudden.

Finally, data on the Intention Factor indicated that the low-knowledge group perceived mutation as being more intentional compared with the middle- and high-knowledge groups, suggesting that the middle- and high-knowledge groups held a stronger belief that mutation is a natural phenomenon and therefore is unavoidable in comparison to the low-knowledge group. Condit and O'Grady (23) have explored interpretations of the term *mutation* held by lay and expert audiences. Both groups regarded mutations as being a variation but not as a planned or an intentional one. Experts regarded mutations as being necessary and not as being undesirable, whereas the lay group tended to be significantly less likely to see mutations as being necessary or as desirable. That the factor score for the Intention Factor, including intended/unintended and avoidable/unavoidable, was affected by knowledge about mutation suggests that the intentional impressions of the term *mutation* might be different in lay people. Differences of knowledge regarding the concept of mutation might affect the acceptance of the process of genetic diseases. Iwamitsu (24) has stated that it was important for patients and their families to be provided with at least a minimum amount of medical information about their diseases as soon as possible. This is also true in the area of genetic counseling and educational intervention.

Regarding the term *mutation*, the relationship between the image of genetics and the depth of understanding regarding genetics should be noted. However, there are a few reports regarding the image of genetics in relation to knowledge about genetics. Genetic developments have been found to evoke both positive and negative feelings in public and professional groups, but with the public being less positive overall than the professionals (25). That study compared lay people with experts; however, there are no studies that have investigated differences between different groups of lay people with different degrees of knowledge.

The usage of the term *mutation* is problematic as a scientific word because of the confusion regarding its use (26). Along with the popularization of genetic testing, in clinical practice, this confusion might result in confusion in the understanding of lay people. It is a very important clinical issue that public understanding and attitudes regarding genetics affect the attitudes of lay people regarding genetic testing. As a whole, lay people (including patients and caregivers) with a high level of knowledge about genetics had more positive attitudes about genetic testing (27–33), but higher levels of knowledge about genetics were also related to negative attitudes (33). Geneticists and genetic counselors should provide accurate information to their clients after taking into consideration how the term should be used in order to encourage the acceptance of genetic testing. Moreover, not only it is important for healthcare professionals to provide accurate information but also they should check with clients about the meaning that the terms used have for each individual. These considerations may be helpful for better communications between clients and healthcare professionals.

Limitation and perspectives

In this study, we suggested that the three Japanese terms *mutation of gene*, *change of gene*, and *lesion of gene* have different impressions, although they have similar meanings. In previous studies, certain terms including 'change', 'variation', 'version of gene' (10), 'faulty gene', 'altered gene' (11), and 'functionally challenged gene' (23) have been proposed as alternatives to the term *mutation*, which has a negative impression. In the study on communicating with cancer patients, Dunn et al. (34) showed that exposure to the word 'cancer' in a questionnaire, as opposed to the word 'illness', increased anxiety

of these patients about the use of euphemism. However, they also described that the use of the word 'cancer' did not affect psychological adjustment, and it might have enabled patients to think about their cancer realistically. As is the case with genetic counseling, the term *mutation* is the accurate term for change in genetic information. We should discuss how to reduce ambiguity in genetic terms and become aware of using the term *mutation* in the clinic.

This study has several limitations that should be noted. The findings suggest that there were significant insights even in the limited participants consisting of Japanese university students and auditing students who agreed to participate in this research. There are several clinical implications of the present findings, but further research on the impressions of the term *mutation* on patients with genetic diseases and their families is needed to understand more useful implications for genetic counseling. Erbllich et al. (35) have demonstrated that women with the stress of having a family history of breast cancer exhibited more interference on a stroop task with cancer-related stimuli compared with women without a family history of cancer, although this bias was not mediated by the significantly higher perceived risk, general distress, or cancer-specific distress in women with a family history of cancer. Constans et al. (36) have suggested that the level of heart-related worry and emotional distress in myocardial infarction (MI) patients were not associated with the degree of attention bias to cardiac stimuli in the post-MI participants but were associated with their monitoring coping style. These findings suggested that maladaptive alterations in processing of disease stimuli might have important clinical implications. This is particularly the case with genetic disease patients and their families who must process complex genetic-related information critical to their health.

In conclusion, when applied to the area of genetic counseling, the findings of this study suggest that healthcare professionals should demonstrate an awareness of the different terms that are used to refer to the identical concept of mutation. This is of particular importance when communicating with patients and families.

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