Practical Whole Body Counter Training for Integrated Learning in Radiation Education

Koji Uchiyama[1]

Corresponding author: Mr Koji Uchiyama koji-u@dokkyomed.ac.jp
Institution: 1. Dokkyo Medical University
Categories: Educational Strategies, Professionalism/Ethics, Medical Education (General)

Received: 28/06/2016
Published: 01/07/2016

Abstract

Radiation education for medical students, especially in the field of human radiation effects and its protection for public health, was one of the issues of social concern in Japan after the Fukushima Daiichi nuclear power plant accident. After the incident, it was felt that all physicians should be required to have an understanding of the fundamentals of radiation sciences; however, the education traditionally given was insufficient and did not address the publics’ anxieties of the health effects from radioactive materials in and around the affected areas of the accident. In an attempt to address this problem, practical training of a whole body counter was conducted on a trial basis at an elective course for first year medical students. This program was intended to instruct them in four new subjects: radiation measurement of the human body, physiological kinetics of radioactive materials, understanding a subject’s anxiety in respect to their contamination by radioactive materials and how to get a medical and personal history from a subject for assessing the cause of internal contamination. This practical training of the whole body counter may have the potential to be one of the education methods of teaching basic radiation sciences for medical students.

Keywords: practical training, radiation education, whole body counter, education method, medical student

Introduction

The Fukushima Daiichi nuclear power plant accident occurred as a consequence of the massive earthquake and associated tsunami that struck the Tohoku and Kanto regions of Japan on 11 March 2011. This accident causes long-term, on-going anxiety for health effects of low dose radiation exposure among the Fukushima residents (Sugimoto 2014). As a result, the ability to provide the general public with psychological assistance for this anxiety is strongly required by medical staffs (Yamashita 2014). Radiation education for medical students is generally valuable allowing them to understand the most
recent medical techniques in the fields of radiation therapy, interventional radiology and molecular imaging and to be emergency responders in the future (Tominaga et al. 2014; Akashi et al. 2010). In addition, radiation education might instruct those doctors whose knowledge of the biological effects of radiation previously was incorrect and prevented them from examining urgent patients (Fukushima Nippo 2013).

Whole body counters are instruments used in monitoring internal exposure by radiation in human subjects. Counters are normally located in nuclear power stations; however, they can be used after nuclear accidents for primary prophylaxis against radiation disease of residents in affected areas, as was true of the Fukushima accident. Various types of counters exist (IEC 2004), upright counters are preferred and mainly used in Japan because they are suitable for monitoring a great number of people in a short time. Usually, a 2 min measurement is required and accuracy is satisfactory (Hayano et al. 2013). However, we used the chair type whole body counter at Nihonmatsu City in Fukushima because of the following three advantages. First, it enabled us to measure elderly persons for whom standing immobile for a 2 min measurement would be too long. Although the chair type required a 10 min measurement to keep the same accuracy as the standing counter, sitting accommodated those persons. Second, this equipment enabled measurement of claustrophobic patients. Almost all other counters are completely surrounded by lead shielding as it reduces environmental radiation; however, the lead shielding of this equipment is designed with a shield that has no top, but is still able to reduce environmental radiation. Third, the operator can easily be accessible to subjects during their measurements. Operators were able to conduct medical interviews in parallel to the measurement taken and to provide appropriate care for reducing the anxiety and stress of the subjects. Usually, just before or during measurement, a subject would think about a possible negative result and become nervous. We found that this ability to provide real-time care was important to the public and this advantage was useful for teaching medical interview techniques, and perhaps might offer students a good opportunity to see how a subject may react during radiation measurement. Practical training by using the chair type whole body counter was planned and conducted because it gave instructors a new methodology in radiation education.

This was a retrospective study of the practical training by using a whole body counter as integrated learning (Prideaux & Ash 2013) for seeking the possibility of simulation-based radiation education, designed to learn how to measure internal exposure from the perspective of physics and to deal with public anxiety regarding radiation effects from the point of view of public health.

Methods

The chair type whole body counter (AZ-S.I.M.; Anzai Medical Co., Ltd., Tokyo, Japan) at Nihonmatsu City in Fukushima was used. After measuring a subject, this equipment could semi-automatically evaluate the internal residual activities of iodine 131 ($^{131}$I), cesium 134 ($^{134}$Cs), cesium 137 ($^{137}$Cs), and potassium 40 ($^{40}$K) and soon display the results on a screen. Seven students participated in this practical training and role-played subjects and operators. While going through a measurement procedure, the student that took turn as an operator would sit by the subject’s side. They would perform a background medical check, giving real time care if necessary, and then begin a more personal interview focusing on the subjects recent activities as shown in Figure 1. Because the whole body counter measurement is a snapshot of the internal radio contamination, the information from the interview was used to assess any future risk, i.e. to explore whether the subject had any possibilities of internal exposure by eating potentially contaminated foods, etc. After the measurement was completed, the operator checked the results displayed on the screen and explained them to the subject. If internal radioactive contamination
was detected, we instructed the operator to perform a check of the gamma-ray spectrum for confirmation of the contamination and to understand whether the result was true or false, then how they ought to evaluate internal dosimetry based on the intake scenario estimated from the medical and personal interviews if the contamination was true.

The raw data of the whole body counter measurements were provided to each student with an Excel VBA developed by the author. As shown in Figure 2, the Excel VBA consisted of some essential and useful programs for medicine, such as non-linear least square fitting programs using Microsoft Excel Solver (Walsh & Diamond 1995) and a numerical integration program using Simpson’s rule to determine the internal residual activities of $^{134}$Cs, $^{137}$Cs, and $^{40}$K. This could show almost all of the processes of gamma-ray spectrum analysis in a familiar Excel sheet so that the students could easily learn more on the subjects of basic and detailed radiation physics and computer techniques if they wanted.

At the end of this pilot program, we conducted a free format questionnaire to the students. The results were analysed retrospectively for this study by means of text mining with the Japanese morphological analysis software, WinCha 2000 R2 (Matsumoto et al. 1999). Free comments in Japanese were first segmented into words, nouns were extracted and arranged in order of frequency of use.

Figure 1. Whole body counter measurement.
No internal radio contamination of $^{134}\text{Cs}$ and $^{137}\text{Cs}$ was found. In contrast, $^{40}\text{K}$ which is well known as one of naturally occurring radionuclides in human body was observed 56 Bq kg$^{-1}$ on average in all students.

**Results**

No internal radio contamination of $^{134}\text{Cs}$ and $^{137}\text{Cs}$ was found. In contrast, $^{40}\text{K}$ which is well known as one of naturally occurring radionuclides in human body was observed 56 Bq kg$^{-1}$ on average in all students.
this was in good agreement with about 2.0 g kg⁻¹ in the UNSCEAR 1962 report (UNSCEAR 1962).

Text mining analysis results were summarized in Table 1. The original Japanese words are in parenthesis. The frequencies of usage and the number of students using each word were presented. All of the students used words such as “Radiation”, “Practical training”, and “Whole body counter”. More than half used “Fukushima”, “Measurement”, “Medical interview”, and “Instrumentation”.

<table>
<thead>
<tr>
<th>Morpheme</th>
<th>Frequency</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiation (Hoshasen)</td>
<td>23</td>
<td>7</td>
</tr>
<tr>
<td>Practical training (Jisshu)</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>Fukushima (Fukushima)</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>Exposure (Hibaku)</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Measurement (Sokutei)</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>Whole body counter (Whole-body-counter)</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Medical interview (Monshin)</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Internal (Naibu)</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Radioactive (Hoshano)</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Instrumentation (Keisoku)</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Anxiety (Fuan)</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Knowledge (Chishiki)</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

**Discussion**

This practical training was carried on 31 August 2013, about two and a half years after the Fukushima accident. Although low doses of radio contamination of foods are still observed in the market place even five years past the Fukushima accident (Tochigi Prefecture 2016), internal exposure was already extremely rare at that time, so that no internal radiocesium contamination was fully expected (Tsubokura et al. 2013; Hayano et al. 2013). Nevertheless, two of the seven students could experience pre-measurement anxiety of internal contamination. Providing this type of experience offers students the capacity to empathize with a subject, and then medical professionalism (Gliatto & Stern 2013). The whole body counter affords an advantage for obtaining medical professionalism because no other radiation medical equipment can be used in this type of training as it avoids unnecessary radiation exposure.

The skill most required in whole body counter training is the physical measurement of radiation. Regrettably, the participating students seemed not to be interested in radiation physics, as based upon the free comments shown in Table 1, more than half, in contrast four of seven students were more interested in the medical interview. This may suggest that medical related subjects motivate medical students to learn basic science even if the students had never been interested in the main subject before.

It should be noted that a limitation of this study was the small number of participants included in it. Selection bias could not be avoidable because this practical training was conducted as an elective course for the first year medical students. It could be possible that those students initially participated believing that the course was focused on the dangers to health due to radioactive materials. Students soon became aware that the course centred on knowledge of pharmacokinetics, internal dosimetry including physiological kinetics of radioactive material, which they did not possess. The course introduced these
new subjects to them but needed more time to be dedicated to these new areas of study. If the students had been better prepared, they would have been more motivated and it is felt that this would have been reflected in their comments submitted at the end of the course.

**Conclusion**

The practical training of the whole body counter was conducted on a trial basis as an elective course for first year medical students, who were predetermined to learn medicine. To attempt to teach the basic sciences to these students was possible because the manifestation of the relationship between basic science and medicine played a key role in giving them motivation to learn basic sciences. It is hoped that the practical training of the whole body counter will become part of our institute’s integrated learning for its radiation education program.

**Take Home Messages**

- The practical training of the whole body counter has a possibility to become one part of integrated learning of radiation physics and medicine.
- Performing medical interviews during training, which are required to consider the pathway of internal contamination, may motivate students to learn physical radiation measurement of the human body.
- Practical training using the whole body counter may lead capacity to empathy, which plays a key role in educating medical professionalism.

**Notes On Contributors**

Koji Uchiyama holds a master’s degree in physics and had 11 years experience of training physicians in the use of handheld gamma cameras for radioisotope navigation surgery in the OR. Currently an assistant professor at Dokkyo Medical University.

**Acknowledgements**

The author would like to thank Dr. Kiyoshi Ishii and Dr. Teruhito Furuichi (Dokkyo Medical University) for supporting the development of this practical training program along with Dr. Yoshikazu Miura (Dokkyo Medical University) for his helpful advice and encouragement. We also thank Mr. Susumu Tanno (Nonprofit Organization Institute of Radiological Hygiene) and Mr. Masataka Kumamoto (Nihonmatsu City Office) for their technical support during this training, and Dr. Masahiro Katou (Green Technologies Co., Ltd.) and Mr. Takeshi Sasaki (Anzai Medical Co., Ltd.) for designing the topless lead shielding of the whole body counter. We would like to acknowledge the officers of Nihonmatsu City government for their help, all seven students for their participation, and Mr. William G. Hassett (Dokkyo Medical University) for his English language review. A part of this paper was presented at the physics education session of the 69th annual meeting of the Physical Society of Japan in March 2014 at Shonan campus of Tokai University, Hiratsuka-shi, Kanagawa, Japan.
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Appendices

Declaration of Interest

The author has declared the conflicts of interest below. The author worked for Anzai Medical Co., Ltd as an engineer since August 2003 through March 2013, was in charge of the system design, installation, and calibration of the whole body counter we used as the chief engineer.