Development of the Virtual Physical Assessment Learning Material That Allows the Learners to Check Drug Efficacy and Early Detection of Adverse Effects through Virtual Experience

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We utilized the information and communication technology to develop the physical assessment (PA) learning materials in the virtual experience type. This learning material consists of two parts which include case learning and basic learning. We created example scenarios about various conditions that a pharmacist may experience in medical scenes such as in a hospital ward, community pharmacy, home, and drugstore. Illustrations of a virtual patient’s avatar before and after taking the medicines were incorporated in the learning materials. The virtual training includes a stethoscope that was used in examining sounds (heart, pulmonary and bowel sounds) that served as evidences in the confirmation of drug efficacy and its possible adverse effects. In addition, we included the images of each body part, the 24 format questions, the palpation (rate and rhythm) of the radial artery, brachial artery and pedal artery, the clinical data obtained from several medical equipment, the pupillary reflex, and the urine dipstick test. This way, learners are able to experience PA with reference to the subjective and objective data from patient reception and questions. The virtual patient’s avatar displayed on the monitor features auscultatory sounds on the stethoscope. It also features clinical data obtained from other medical equipment that can give the learners an interactive way of learning about various medical conditions. For evaluation, we gave out questionnaires on the virtual PA to pharmacy students. As a result, a high evaluation was reflected in terms of the degree of usefulness for both case learning and basic learning.

Key words—physical assessment; learning material; e-learning; information and communication technology; questionnaire

INTRODUCTION

Currently, pharmacy students and pharmacists are learning physical assessment (PA) through clinical practice and lifetime education workshops in the university, local pharmaceutical association and society.¹–⁶ However, there are only few opportunities to learn it and very limited learning materials available. We have already introduced the pharmaceutical universal training model and the patient simulator in the School of Pharmaceutical Sciences, Kyushu University of Health and Welfare, where we conduct trainings on vital signs and PA.⁷–¹² Several scenario programs and animations of the patient simulator, which we use in these practices, can be viewed through our previous homepage.¹³,¹⁴ So far, the practice of using the patient simulator has established

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the virtual PA were given to pharmacy students. In this article, we are going to report contents and survey results on the virtual PA learning material that we have developed.

**METHODS**

**Making of the Scenario Program** We created several example scenarios about various conditions that a pharmacist may experience in medical scenes such as in a hospital ward, community pharmacy, home, and drugstore. We incorporated illustrations of a virtual patient’s avatar’s conditions before and after taking the medicines. A stethoscope on the monitor was also used in examining sounds (heart sounds, pulmonary sounds and bowel sounds), which we used as evidences in the confirmation of patient’s condition, drug efficacy and its possible adverse effects. In addition, we included the images of each body part, 24 format questions, the palpation (rate and rhythm) of radial artery, brachial artery and pedal artery, the clinical data obtained from the medical equipment, the pupillary reflex, and the urine dipstick test. The details are shown in Supplementary Table 1.

**Development of the PA Learning Material** The learning material is in web form and was used as a reference for the subjective data. This subjective data include the virtual patient’s avatar displayed on the monitor while the objective data include the clinical data obtained from the vital signs and medical equipment interactively used by the learners. Heart sounds, pulmonary sounds, bowel sounds and Korotkoff sounds have all been synthesized. The details are shown in Supplementary Table 1.

Adjustments on these sounds have been made to distinguish one from the other because each part exhibits a different sound in actual observation: the heartbeat (aortic valve domain, pulmonary valve domain, tricuspid valve domain and mitral valve domain); the pulmonary sound (anterior: trachea domain, upper lung field domain and lower lung field domain, posterior: upper lung field domain and lower lung field domain). Furthermore, we synthesized various wave patterns that correspond to that of an ambulatory electrocardiogram (ECG) monitor.

**Evaluation by the Students** We surveyed on the degree of usefulness of the following assessment items using the unsigned questionnaires that we collected from pharmacy students after the latter-term bedside training (on the final day): e-learning (basic learning (slide form), basic learning (animation form), and case learning (whole)], virtual physical assessment (“hearing sounds” “observing the body” “palpating the pulse” “asking questions” “using medical equipment” and “reading data”). In addition, we surveyed on the degree of difficulty of each case learning. The respondents comprised 125 fourth year students in the School of Pharmaceutical Sciences. We surveyed on the degree of usefulness through a check method using the following ratings: “Very useful, Useful, Normal, Not useful, and Not useful at all”. The degree of difficulty was also surveyed using the following ratings: “Difficult, Slightly difficult, Normal, Slightly easy, and Easy”. To calculate the degree of usefulness, we assigned 5 points each for the ratings “Very useful” and “Difficult”. The succeeding ratings received a deduction of 1 point each, with 1 point as the lowest, which was assigned to the ratings “Not useful at all” and “Easy”. Then, the average of the degree of usefulness and degree of difficulty were calculated by dividing the total scores gathered by the total number of respondents. Furthermore, we also asked for the time required to finish each case study.

**RESULTS**

**Making of the Scenario Program** We created example scenario programs which may be experienced by pharmacists while in the field. The scenario cases are as follows: 6 scenario program cases in a hospital ward, 16 cases in a community pharmacy, 5 cases at home, and 3 cases in a drugstore. These scenarios were made in reference to the corresponding manual of the serious adverse effects of medicines, the books involved in drug therapeutics, and the case study questions in the pharmacist national examination, etc. Depending on the scenario, the virtual patient may return to his/her normal state by taking the prescribed medicines. Otherwise, adverse effects may develop. The primary diseases, adverse effects and causative medicines used in these cases are shown in Supplementary Table 2.

**Development of the PA Learning Material** The physical assessment learning material consists of two parts which include case learning and basic learning. The steps in the scenarios which are used in case learning are arranged in the order of A, B, and C, with an additional commentary, F, as the final step (Fig. 1). With step A, the learner can obtain relevant information such as the patient’s history of present
illness and the drug prescription, and then start with the assessment. With step B, the learner can assess the continuation of the medical condition, the recovery, and the onset of the adverse effects of the medicines. With step C, the learner can assess the progress of the adverse effects caused by step B and other observable changes in the patient’s condition. Finally with step F, the learner can read all the commentaries for steps A, B, and C. With the aim of making it more realistic, we made 4 background locations to help the learner understand more clearly the patient reception of the pharmacist within a hospital ward, community pharmacy, home, and drugstore.

**Assessment Items** We prepared the assessment items such as “hearing sounds” “observing the body” “palpating the pulse” “asking questions” “using medical equipment” and “reading data” (Fig. 2). In “hearing sounds”, the learner can click
on the stethoscope’s chest piece on the monitor and drag it to the area to be observed (heart, pulmonary and bowel). A box with dotted lines will appear when it is moved to the accurate hearing point. The learner is then able to clearly listen to the sound at that point. For accuracy, the rhythm of the heart sounds and the pulmonary sounds have been regulated according to the different pulse rates and the breathing rate of each virtual patient. The assessment of “hearing sounds” allows the learner to identify normal sounds and various abnormal sounds. Furthermore, it enables the learner to compare his answers for the questions with the correct answers through the “learning result display”. Incorrect assessment is displayed through a rubric in the learner’s history table. As indicated in Supplementary Table 1, the learner can check the illustrations of items of each body part under the assessment of “observing the body”. The learner can confirm the palpation of radial artery, brachial artery and pedal artery in the assessment of “palpating the pulse”. Under the assessment of “asking questions”, the learner can ask questions in the form of “do you have/feel…?”. Under the assessment of “using medical equipment”, it is possible to display the clinical data obtained through the use of the different medical equipment indicated (Supplementary Table 1 and Fig. 3). This system program has been set in such a way that it is possible to irradiate the eyes using a virtual penlight in the assessment of the pupillary reflex. During irradiation, if the patient’s condition is normal, they change to miosis. On the other hand, if the condition is abnormal, they change to sustained miosis or inequality of both left and right eyes. In cases of life-threatening situations, it changes to mydriasis. Through the use of the urine dipstick test, the results of the uric sugar, uric protein, and uric blood are displayed in plus or minus. Finally, under the assessment of “reading data”, the learner can confirm the clinical data and prescription information, and read the attached document information of Pharmaceuticals and Medical Devices Agency by clicking the tab “medical products”.

Fig. 2. Assessment Items about Physical Assessment
In Fig. 2, step B of hospital ward case No. 2 is shown.

[A] Hearing sounds: The heart sound, pulmonary sound, and bowel sound are played for 10, 20 and 60 s, respectively. Please evaluate the normalcy or the abnormality in the indicated time mentioned above.

[Question] What was the heart sound heard in this case?

- normal,
- bradycardia,
- tachycardia,
- III sound,
- atrial fibrillation,
- extrasystole,
- long QT,
- III sound,
- IV sound,
- tachycardia + III sound,
- tachycardia + III + IV sound.

[B] Observing the body: Cheyne-Stokes’ breathing.

[C] Palpating the pulse

[D] Asking questions: (Do you feel any pain?) no answer.

[E] Using medical equipment: [Question] How was the pupillary reflex of this case? Normalcy or abnormality.

[F] Reading data: Cerebral hemorrhage is confirmed in head CT. JCS: 300.
Basic Learning  The other contents have been created to be read and learned in slide form and animation form in basic learning, as well as in case learning.

The slide form contains information on how to use a stethoscope for pulmonary sound hearing, heart sound hearing, and bowel sound hearing. This slide form also contains information on how to use a sphygmomanometer for blood pressure reading. In basic learning, it is possible to review the commentaries in the slide form, and on how to auscultate the pulmonary sounds, heart sounds, and bowel sounds, as it is important for pharmacists to identify the different sounds and distinguish between normal and abnormal sounds. All the sound sources used are synthesized sounds. Hence, the learner can confirm the following sounds: the pulmonary sounds (normal, wheezes, bubbles and fine-crackles); the heart sounds (normal, S3 gallop and S4 gallop); the bowel sounds (normal, increased condition, decreased condition, sub-ileus and ileus).

On the other hand, the animation form consists of the following 8 items: Introduction, Vital signs part 1 pulse/breathing, Vital signs part 2 blood pressure, Demonstration of the blood pressure measurement, Vital signs part 3 temperature/consciousness, Physical assessment part 1 pulmonary sound, Physical assessment part 2 heart sound/bowel sound, and Physical assessment part 3 summaries.

All these learning materials are available free of charge in the exclusive homepage.

Evaluation by the students The degree of usefulness of case learning (whole), basic learning (slide form) and basic learning (animation form) in the e-learning that we made are 4.49 ± 0.63, 4.32 ± 0.64 and 4.29 ± 0.72, respectively. In addition, case learning (virtual PA) was evaluated with a higher degree of usefulness according to the order of “hearing sounds” [4.54 ± 0.62], “using medical equipment” [4.38 ± 0.65], “asking questions” [4.38 ± 0.68], “reading data” [4.35 ± 0.68], “observing the body” [4.27 ± 0.69], and “palpating the pulse” [4.15 ± 0.76]. The average time needed in experiencing each case learning was 36.0 ± 23.9 min (mean ± S.D.). Moreover, the degree of difficulty of the case learning that was experienced was 2.94 ± 0.82 [maximum value of 3.75 ± 0.96 (hospital ward case No. 2), and minimum value of 1.75 ± 0.96 (community pharmacy case No. 12)] (Supplementary Table 2). The flowchart of the case study having the highest degree of difficulty is shown in Fig. 1. The Cheyne-Stokes’ breathing and inequalities in the right and left pupilla-
ry reflexes in this case study may be quite complicated.

**DISCUSSION**

We created 30 example scenario programs which pharmacists may experience in the various medical scenes, and showed them as virtual PA. Even though the results from the questionnaires given out to the respondents show that the degree of difficulty of the case learning was assessed as “Normal”, learners in general still have to finish studying about the vital signs and basic PA before they can start to use these scenario programs. Therefore, we devised this e-learning material to help the learner acquire basic learning knowledge in “slide form” and “animation form”. In the future, we would like to improve the website by indicating the degree of difficulty in each case study so that the learners will be able to choose the level of difficulty of each case study accordingly and therefore, find it more convenient to use. Furthermore, we would like to ask more detailed questions to the general learners to be able to gather their feedback in order to improve the version in the future.

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**Conflict of Interest**  The authors declare no conflict of interest.

**Supplementary Materials**  The online version of this article contains supplementary materials.

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