The Introduction and Effectiveness of Simulation-based Learning in Medical Education

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Abstract

Objective To contribute to reforming the medical education system in Japan, we visited overseas medical schools and observed the methods utilized in medical education.

Materials and Methods We visited 28 medical schools and five institutes in the United States, Europe, Australia and Asia in 2008. We met deans and specialists in medical affairs and observed the medical schools' facilities.

Results Among the several effective educational methods used in overseas medical schools, simulation-based learning was being used in all that we visited. Simulation-based learning is used to promote medical students' mastery of communication skills, medical interviewing, physical examination and basic clinical procedures. Students and tutors both recognize the effectiveness of simulation-based learning in medical education.

Conclusion In contrast to overseas medical schools, simulation-based learning is not common in Japan. There remain many barriers to introduce simulation-based education in Japan, such as a shortage of medical tutors, staff, mannequins and budget. However, enhancing the motivation of tutors is likely the most important factor to facilitate simulation-based education in Japanese medical schools to become common place.

Key words: medical education in the world, simulation-based learning, skills laboratory

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Introduction

Clinical skills training should be one of the most important courses in medical education. Medical students must master communication skills, medical interviewing, physical examination and basic clinical procedures in clinical skills training. Although such training using real patients is most effective in learning clinical skills, there is a limitation in using real patients in terms of the legal and ethical viewpoints in Japan. To overcome such limitations, simulation-based education such as the use of mannequins is considered useful.

Peyton recommends four steps for medical students to take to master clinical skills: demonstration, trainer goes through it with learner, trainee talks it through in front of trainer and trainee performs the skill (1). Simulation-based

education meets the concept of this four-step theory. Medical students are able to perform clinical practice safely and repeatedly in a standardized circumstance using simulators. It is easy for students to assess their clinical practice by themselves. The evaluation of the clinical skills of medical students is feasible in a standardized manner. Actually the usefulness of simulation-based education has been shown to improve the relationship between patients and students, the clinical activities of the students on the ward, and the safety of medical practice (2-5).

Simulation-based education is thus considered very effective for medical students to learn and master clinical skills. However, we noted that simulation-based education was not common in Japanese medical schools. We analyzed the prevalence of simulation-based education in 80 medical schools by questionnaire (6). Seventy-three schools responded to the questionnaire and were entered in the study.

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Table 1. Medical Schools We Visited in the Project

1) Europe

England: St. George's University, King's College

Scotland: University of Dundee, University of Glasgow

Ireland: University of Dublin, Royal College of Surgeons in Ireland

the Netherlands: University of Leiden, Free University of Amsterdam

Belgium: Free University of Brussels

Spain: University of Barcelona, University of Alcala

Germany: University of Heidelberg, University of Würzburg, Charité University of Berlin, Technical University of Munich

2) United State of America

Stanford University, University of California San Diego, University of Nevada

3) Australia

University of Melbourne, University of Sydney, Australian National University, University of New South Wales

4) Asia

Malaysia: University of Malaya, University Kebangsaan Malaysia, Penang Medical College

Korea: National University of Seoul, National University of Pusan, Yonsei University

Among the 73, only 59 schools owned a skills laboratory for simulation-based education and 49 of those schools included training in a skills laboratory in their regular curriculum.

We visited 10 overseas countries to observe the application and effectiveness of simulation-based education in medical schools (7). We noted active use of simulation-based education and saw its effectiveness in helping medical students master clinical skills. We believe that the introduction of this educational system would be very useful to promote the use of simulation-based education in Japan.

Materials and Methods

We visited 28 medical schools in 10 European, Australian, American and Asian countries as a delegate of the Ministry of Education, Culture, Sports, Science and Technology of Japan, in February to November 2008 (7). The medical schools we visited are shown in Table 1. In the project we met deans, specialists in medical education and student affairs personnel to discuss the educational system in each medical school. We obtained information about the admission process, curriculum, syllabus, clinical skills training, clinical clerkship and assessment, research activity, medical board examination, and residency program at each location. We also observed the medical schools' facilities, including lecture theaters, tutorial rooms, skills laboratories, libraries and teaching hospitals. In some countries we visited medical councils or ministries of health to learn about the system of medical administration.

Results

The admission, educational system and residency programs varied among the countries (Fig. 1). There are three types of educational systems. One is the 5-7 year program which educates students who are high school graduates. This type is seen in Germany, the Netherlands, Belgium, Spain, Scotland, and Malaysia. The second type is the 4 year program which educates college graduates; this type is seen in

Figure 1. a-c: Framework of medical education in the world, showing the various types of medical educational systems in the world. a: Germany, b: USA, c: Australia

U.S.A. The third type is the program which accepts either college or high school graduates. This type is seen in Australia, England, Ireland, and Korea. Some medical schools accept exclusively either high school or college graduates, while other schools accept both.

Although the curriculum varies among medical schools, all medical schools focus on education which teaches clinical skills. To meet this purpose, they stress the importance of clinical training. There are various approaches in clinical training; one approach is simulation-based education.

Students can learn the following by simulation-based edu-

Monday	Tuesday	Wed	Thursday	Friday
PBL tutorials	Clinical Lectures			
specialized module sessions			skills-lab/ communica tion training with SPs/ teaching rounds	skills-lab: individual training
Peer-assisted learning	Mentoring-Tutoring-Programm	skills-lab/ communica tion training with SPs/ teaching rounds		
advanced skills training				
clerkship on ward				

Figure 2. Curriculum of clinical medicine at the University of Heidelberg. Training of clinical skills in skills laboratory is integrated in the clinical clerkship. Every module takes 2 weeks (timetable for 1 week). SPs: standardized patients, PBL: problem-based learning

cation:

- Structure and function of the human body
- Communication skills
- Physical examination
- Clinical practice (diagnosis, treatment, resuscitation, etc.)

Several kinds of simulators are available. These include fellow students, the staff, standardized patients (SPs), mannequins, animal organs and computer software. The simulators are used to meet the purpose of clinical training. For instance, students, staff and standardized patients are used to master communication skills, medical interviewing and physical diagnosis. Mannequins and animal organs are used to master medical procedures such as venipuncture and suturing. Sophisticated mannequins and computer software are used to mimic pathophysiological situations in several diseases, in which students can learn diagnosis and treatment.

Simulation-based education is integrated in clinical training in the regular curriculum of most overseas medical schools (7). Medical interviewing and the physical examination are taught early in the medical curriculum, while the training of medical procedures is done before or during the clinical clerkship. The curriculum of clinical training using a skills laboratory in the University of Heidelberg, Germany is shown in Fig. 2.

The largest concern of simulation-based education is its effectiveness and value. There is no substantiating evidence to support the notion that simulation-based learning actually helps produce better doctors compared with traditional teaching methods (8). However, most instructors and students acknowledge the usefulness of simulation-based learning to master clinical skills. Students accept simulation-based learning as a useful method by which they can practice safely and repeatedly anytime.

Among several methods of simulation-based learning in overseas medical schools, the following are considered useful to be used in Japanese medical schools.

1. Role play acted by instructors

Sophisticated mannequins are used in some medical schools (Fig. 3). The mannequin is controlled by computer and its circulatory and respiratory function can easily respond by use of software. Some scenarios such as acute myocardial infarction or bronchial asthma are included in the computer software. A medical instructor plays the role of a patient according to the scenario and speaks via microphone from the next room. Circulatory and respiratory functions are shown on the computer desktop and changeable according to the scenario. Students stand in front of the mannequin and ask questions. The medical instructor answers and medical students try to make a diagnosis. In some conditions, students are required to treat. They choose a syringe with a bar-code which names the drug and its dosage, and inject it into the mannequin. The response to the injection is reflected on the computer. Thus the diagnosis and treatment chosen by the student can also be evaluated on site.

This type of training is very useful for students to learn medical practice. The objective evaluation of clinical skills is also feasible. The shortcoming of this training, however, is that the mannequin is expensive and it needs specialized equipment and staff.

2. Management of skills laboratory by students

One of the biggest barriers to the usage of simulation-based education in Japan is the shortage of medical staff to manage skills laboratories. In fact, only 15 medical schools employ full-time staff for their skills laboratories; the other 44 schools do not assign full-time staff.

This problem is not specific to only Japan. To overcome the shortage of human resources, students are involved in the management of their own skills laboratories in Germany and Spain. The system is not only effective to remedy the shortage of medical staff, but also useful for students to learn whenever they want. Moreover students of higher classes teach clinical skills to students of lower classes. This teaching promotes learning for the teacher and the student.

3. Usage of animal materials

Even though mannequins are made to mimic the human body, the mannequins are not the same as a human body. As one of the approaches to overcome this limitation, animal materials can be used in simulation-based learning. Porcine skins and gut preserved in alcohol are used to learn surgical suturing in a skills laboratory at the Technical University of Munich (Fig. 4). Animal materials are more similar to human tissues than mannequins. Both students and instructors accept animal materials as useful simulators to learn medical procedures. Although it may not be easy to obtain animal materials in Japan, this learning system is considered useful to introduce here.

Figure 3. Role play acted by instructors. Medical instructor acts via microphone with a mannequin as the patient. Students can learn the diagnosis and treatment using the mannequin.

Figure 4. Training of suturing skins using porcine materials preserved in alcohol.

4. Assistance of delivery

All medical students need to learn how to assist in obstetrics. However, it is not often that students can learn delivery techniques in university hospitals in Japan. Simulation-based learning is an alternative way to learn delivery. The simulation system using computer technology has been developed at the Technical University of Munich. Students learn how a baby comes through the birth canal by simulation. They can also try to perform vacuum extraction according to the computer guide (Fig. 5). Simulation-based learning of delivery is also used in some other countries such as Korea where the opportunity to learn delivery is not common in teaching hospitals. Introduction of this learning system should also be helpful in our country.

Discussion

We visited and observed medical education in 28 overseas medical schools in 2008. All schools considered it most important to teach clinical skills to students. They include communication skills, medical interviewing, physical diagnosis and basic medical procedures. Simulation-based learning is effective for students to learn clinical skills before entering the clinical clerkship where students learn using real patients as a member of the medical team. Students can learn clinical skills safely and repeatedly by simulation-based education. Evaluation of the clinical skills of the students is also possible.

Although the effectiveness of simulation-based education is widely appreciated, it is not common in medical education in Japan (6). There are some reasons to explain the low

Figure 5. Simulation of delivery. Students can experience vacuum extraction in a virtual situation.

frequency of simulation-based education in Japan. The low supply of mannequins, the shortage of funding, and the lack of full-time staff are noted to be major reasons. However, the poor motivation of instructors involving simulation-based education is considered a more serious reason. In fact, approximately 81% of medical schools in Japan have skills laboratories for simulation-based education. About 83% use them in their regular teaching curriculum. However, the time given to simulation-based education is less than 20 hours per year in almost half of our medical schools which use skills laboratories training in their regular curriculum.

To develop simulation-based education in the medical schools in our country, the introduction of the successful systems of overseas medical schools would be helpful. The educational system of role play models is effective for students to learn clinical skills in situations which come close to real patient contact (Fig. 3). The management by students of the skills laboratory should be helpful to overcome the lack of full-time staff. Usage of animal materials provides clinical a skills training system under conditions similar to the human body.

Moreover, motivation of instructors is likely the most important to develop a simulation-based education. The number of instructors is absolutely lower in Japan than in the United States of America (9). Instructors in Japanese medical schools are often too busy to spend a sufficient amount of time teaching students. They are usually required to do clinical practice in the hospital and outpatient clinic, carry out medical research, and teach medical students. It is often difficult to find enough time to successfully accomplish all of these tasks. They often give preference to either clinical practice or research. However, the importance of medical education cannot be over-stated.

Several methods of medical education are considered useful to help busy instructors. One is simulation-based learning, where students can learn safely by themselves. Although instructors have to teach students clinical skills in simulation-based learning at first, students are able to repeat and practice clinical skills after the instruction. It is possible that students of senior classes teach junior class students. In this instance, the involvement of instructors is not necessarily required. Therefore, self-learning by students using simulation-based education should help alleviate the problem of instructor inavailability.

Faculty development is useful to promote the involvement of instructors in medical education (10). If instructors understand the effectiveness of simulation-based learning to master clinical skills, they will use it in clinical education. Simulation-based education is not only effective for students to learn clinical skills but also it helps alleviate the shortage of instructors.

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