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Research Paper

A Proposal for Information Science Education for the Training of Paramedics and Medical Technologists in Japan

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Abstract. I have been engaged in information science education for the training of medical technologists at a medical technology college. Up to the present, information science has not always been regarded as an indispensable part of the education of paramedics in Japan. However, along with the recent progress and technological advances in medical test equipment, as well as the promotion of electronic medical recording systems and online receipt of remuneration for medical services as ways of addressing the insufficient number of physicians and their increased workload, the importance of information science and technology, including computer operations, has been growing. In line with this, the recent paramedic licensing examinations have included content related to information science. This paper discusses information science education for effective clinical practice.

Keywords: Medical technology, paramedics, information and communications technology, education.

INTRODUCTION

ICT (information and communications technology) should be promptly introduced in the field of medicine to provide better health care services (Chaudhry et al., 2006; IMIA, 2010; Garg et al., 2011). It has become increasingly important to train well-educated ICT specialists in the health and medical care fields around the world (Jaspers et al., 2005). In fact, various types of education and practical training models have been developed (Hasman and Haux, 2006; Harsh, 2006; Kuhn et al., 2008; Mantas et al., 2010). In Japan, it has been a long time since the importance of ICT began to be highlighted in various fields along with advances in information technology. Basic studies now cannot proceed without computers, while corporate networks via the intranet or extranet for multiple purposes, including document management and e-mail correspondence, have been fully constructed using such technology. ICT has been incorporated in compulsory education, and an increasing number of related qualification examinations have been established in recent years. However, doctors and paramedics have low ICT literacy in Japan (Kohzaki et al., in press).

I have been engaged in ICT education for the training of medical technologists at a college in Japan (Kohzaki et al., 2011; Kohzaki, 2012a; Kohzaki, 2012b; Kohzaki and Sugawara, 2012; Kohzaki et al., in press). ICT has not always been regarded as a necessary part of the education of paramedics, compared to nurses and medical technologists. However, due to the recent progress and technological advances in medical test equipment, in addition to the promotion of electronic medical recording systems and online receipt of remuneration for medical services as ways to address the insufficient number of physicians and their increased workload, the importance of ICT, as well as personal information protection, has been growing. At the same time, owing to highly promoted genetic and cytogenetic

Table 1. Proportion of credits and hours for information science education in the medical technologist training program.

	Information science	English education	Biochemical examination	Clinical physiological examination	Total credit points
Credit points (h)	2 (90 h)	4 (115 h)	10 (330 h)	10 (315 h)	115 (3,435 h)
%	1.7 (2.6)	3.5 (3.3)	8.7 (9.6)	8.7 (9.2)	100

testing services following the Human Genome Project, we live in an age where a genetic test can be ordered via the Internet, using a self-collection kit to submit a blood sample from the fingertip ("23andMe," 2013), which is the ultimate personal information (Kohzaki, 2012a). Under such circumstances, recent national licensing examinations for paramedics have included questions related to ICT, as is the case for medical technologists in Japan.

However, the ICT literacy of students admitted to institutions for training nurses and medical technologists significantly varies, and we were surprised that some students had not even touched a computer keyboard. As educators, we first would like them to acquire skills that enable them to become functioning members of society. Secondly, as educators at an institution for training nurses and medical technologists, we must ensure that students pass the national examinations. Finally, we hope that students develop skills required for nurses and medical technologists to prevent medical accidents in clinical settings. Educators are tasked to accomplish these difficult goals.

Therefore, I have proposed a method for ICT education that can readily be adopted by health care institutions.

MATERIALS AND METHODS

Institutions for training nurses and medical technologists develop and implement curricula designed to help students pass the national examinations, as schools for other health care professionals do. The curricula contain not only theoretical but also practical courses; therefore, fewer hours are dedicated to ICT (Table 1). In such a limited time, it is difficult to obtain sufficient skills in ICT for appropriate clinical practice. As shown in Table 2, the level of ICT literacy required for medical technologists, as reflected in the content covered by the national examination, is defined by the Japanese Ministry of Health, Labour and Welfare. When students of my ICT class took a practice test similar to the national examination following a series of lectures, they could not answer the majority of the questions. In fact, the minimum total number of classes and level of skills required in ICT education established by "institutions for training nurses and medical technologists" are less and lower, respectively, than those stipulated in the guidelines recommended by the IMIA (Kuhn et al., 2008; IMIA, 2010; Mantas et al., 2010). In response to this situation, I developed curricula and syllabi, based on the "Yearbook of Medical Informatics" published by the IMIA (2010), for training medical technologists and other health care professionals, designed to include classes in which they can develop a higher ICT literacy (Table 3).

Although most first-year college students are already skilled in the use of mobile phones, they tend to lack experience in writing and giving presentations using a personal computer (PC). To improve the level of ICT literacy in all students, they initially learn the primary processes of PC operation, such as startup, keyboard usage, and how to connect to the Internet, along with receiving a basic introduction to Microsoft Office software, including Word, Excel, and PowerPoint (Microsoft, 2013) (Table 3). Microsoft Windows is the most common operating system (OS) for clerical work and electronic medical recording at Japanese medical facilities.

As educators, we must ensure that all students develop ICT skills as well as the necessary social skills. Medical technologists are required to learn these skills because medical equipment and devices used to conduct a variety of examinations are run on Microsoft Windows OS (Table 3). Therefore, I developed a syllabus that allows students to develop ICT skills even if they have not acquired a high-school ICT literacy level (Table 3A).

I also developed and implemented the syllabus shown in Table 3B, based on Table 2, to help students prepare for the national examination for medical technologists. I reviewed the examinations for medical technologists for the past ten years to identify trends, and discovered that many questions used in the national examinations for medical technologists seemed more like questions ona national examination to certify ICT specialists; there were security-related questions, including ones on network communication protocols. I devised a flexible syllabus according to the trends of past national examinations for medical technologists and students' ICT literacy levels.

RESULTS

In Japan, many health care workers, including paramedics and medical technologists, are subject to national exams. Of course, certified medical technologists are qualified to perform medical examinations and analyses, including electrocardiograms, ultrasonography, and electroencephalograms, as well as blood sample collection. Being installed on a large number of medical devices for such examinations, Windows OS constitutes

Table 2. Content related to information science in the medical technologist licensing examination in Japan (Ministry of Health).

Categories		
General	Medium	Specific
1. Software	A: Application software	a: Types and roles of application software
2. Computer networks	A: Definitions of networks	a: Intranet (LAN) b: Internet (including WWW)
	B: Network construction	a: Network connecting devices b: Client server systems
	C: Communication and transmission	a: Communication protocols b: TCP/IP protocols c: Network protocols d: Transmission systems
	D: Security	a: Certification ID and password b: Information protection and data concealment (coding)
	E: Internet applications	a: E-mail b: Web browsers
3. Information processing systems	A: System concept	a: Systems and designs b: Flow charts
	B: Host computer processing	a: Online processing b: Time sharing processing
	C: Network server processing	a: Distributed processing b: Network systems
4. Medical information systems	A: Medical information systems	a: Ordering systems b: Electronic medical recording systems c: Remote diagnosis systems d: Medical imaging data processing systems e: Individual qualification/ certification systems
	B: Medical information protection and privacy	a: Knowledge of information protection b: Understanding of privacy c: Information security systems
	C: Medical information system management	a: Data input and output b: Data storage and compression

an indispensable component for clinical performance. Windows computer operations, including writing, calculating, and making presentations, are not just a skill but also an essential requirement for living in today's information society. Therefore, the course Medical Information Management Practices I is aimed at increasing students' understanding of how to use a computer and its role in society. Considering the fact that the average score on the final examination for this course is nearly 80 points every year, it would appear that our goal is being achieved.

The recent national licensing examinations for medical technologists have included an average of 4 questions related to ICT (Table 2) (Ministry of Health, Japan, 2013). As medical technologists cannot be certified without passing the national examination, the course Medical

Table 3A. Information science syllabus for the medical technologist training program: Medical Information Management Practices I.

Course offering	First year, semester 2
Total hours	48
Course mode	Practical
Credit points	1
Course description	To become familiar with computers and multimedia information, learning how to use various types of application.

Course structure		
Classes	**Number of classes**	**Study topics**
Basic operation	2	a. Typing b. Windows c. File management
Writing I	3	a. MS-Word b. Letter input c. Text file management
Spreadsheet software	3	a. MS-Excel b. Spreadsheets c. Graph creation
Painting software	3	a. Painting software b. Digital cameras c. Image creation d. Image data processing
Internet	3	a. E-mail b. Search engines c. Creating html using MS-Word
Writing II	3	a. Insertion of photos and graphs
Database construction	3	a. Database management b. Database creation c. Linking multiple databases
Presentation	4	a. Presentation software b. Creation of presentation materials

Information Management Practices II is aimed at preparing students for the examination; the course covers the basics of computers, network construction, and logic circuits (Table 3B), subjects included on the national examination (Table 2) (Ministry of Health, Japan, 2013). In this course, students study the importance of the binary system in computers and how binary codes are used to represent data, in addition to the means and logics of communication, which are essential for networks (Table 3B). Considering the fact that the average score on the final examination for this course is also nearly 80 points every year, it would appear that students are obtaining a good grasp of the contents on the national examination.

However, the effectiveness of the 2 courses should also be verified by the results of national licensing examinations. Although it was difficult to accurately estimate the outcome of these approaches, they appear to have been effective, considering that scores in national examinations for medical technologists were only 10 points higher than those in my genetic examination class on average (Kohzaki, 2012a).

Table 3B. Information science syllabus for the medical technologist training program: Medical Information Management Practices I.

B. Medical Information Management Practices II	
Course offering:	Second year, semester 2
Total hours	46
Coursemode	Practical
Credit points	1
Course description	To understand computer hardware and network environments, and practice using writing software

Course structure		
Classes	Number of classes	Study topics
Communication network system	15	a. Internet and data processing b. Real-time data c. Data transmission via LAN 1. Image data transmission using a digital camera 2. Basic concept of movies d. Security and morality e. Clinical application 1. Remote medical care f. Laboratory examination data processing and application
Writing	4	a. Practice report writing
Common software	4	a. Introduction to common software

Table 4. Main points of the Personal Information Protection Act (Personal Information Protection Act, 2013).

S/N	Points
1	Notice or public announcement of purpose of use of personal information
2	Collection of personal information with the consent of the person
3	Data integrity
4	Security control measures to prevent leakage, unauthorized access, or loss of personal information
5	Disclosure and delivery of personal information to the person
6	Correction of personal information upon request by the person

DISCUSSION

Since the Personal Information Protection Act was enacted in Japan, stricter information management has been required in Japan (Table 4) (Personal Information Protection Act, 2013). Furthermore, ISO 15189 (ISO15189, 2013), an international standard for medical laboratories, has standardized laboratory examination data, and ISO9001 (ISO9001, 2013) and ISMS/ISO27001 (ISO27001, 2013), as well as JIS Q 15001 (JIS, 2013), a privacy mark system, require high-level information processing skills. As previously mentioned, a variety of certification (Microsoft Office Specialist, Japan Testing Association, 2013) and national licensing (Information-Technology Promotion Agency, 2013) examinations are conducted at present. In addition, a revision to the remuneration procedures for medical services was implemented in 2000, which allowed the additional remuneration for medical record management. This has highlighted the importance of medical record management in hospitals and the status of the “health information manager,” for which there is a certification examination and required qualifications (Japan Society of Health Information Manager, 2013). The duties of health information managers include the following: control and assessment of medical information, such as medical records; information management, including constructing databases of coded medical information; and information utilization, including extracting the necessary information from a database to process and analyze it. Possessing the necessary knowledge and qualifications to perform these duties will also increase their understanding of information science (Table 5).

ICT has been applied to smoothly conduct interdisciplinary health care management, facilitate communication between health care teams and patients,

Table 5. Major certification examinations and qualifications related to information processing in Japan.

MOS/MCAS (Certification examinations) (Microsoft Office Specialist, 2013)	Word, Excel, PowerPoint, Access, Outlook
Information Processing Proficiency Test (Japan Testing Association, 2013)	A certification test to assess information processing proficiency in appropriately using spreadsheets or database-creating software, and develop computer skills for the information society
Information Processing Engineer Examinations (national licensing examinations) (Information-Technology Promotion Agency, 2013)	
1. Information Technology Passport Examination	For individuals with fundamental knowledge of information technology (IT), aiming to enter IT careers or master skills
2. Fundamental Information Technology Engineer Examination	For individuals with basic knowledge, skills, and practical ability to become a high-level IT professional
3. Applied Information Technology Engineer Examination	For individuals with advanced knowledge and skills, who are prepared to become a high-level IT professional
4. Information Technology Strategist Examination	For high-level IT professionals with specialized careers, who plan, propose, and optimize IT-enabled strategies for specific processes involved in business models or corporate activities, in accordance with corporate management policies, and create new values by planning and developing embedded systems
5. System Architect Examination	For high-level IT professionals with specialized careers, who define the requirements for developing information or embedded systems proposed by IT strategists, design them, and, in the case of information systems, lead the process of development
6. Project Manager Examination	For high-level IT professionals with specialized careers, who plan projects, secure the manpower and resources required for them, and manage them to achieve planned quality levels on time and within budget as a system development project manager
7. Network Specialist Examination	For high-level IT professionals with specialized careers, who play a central role or provide technical assistance for planning, defining, developing, managing, and maintaining optimal information system infrastructures by applying network-related technologies as a network specialist
8. Database Specialist Examination	For high-level IT professionals with specialized careers, who play a central role or provide technical assistance for planning, defining, developing, managing, and maintaining optimal information system infrastructures by applying database-related technologies as a database specialist
9. Embedded Systems Specialist Examination	For high-level IT professionals with specialized careers, who construct optimal embedded system development infrastructures, and manage the process of designing, constructing, and producing embedded systems by applying their expertise
10. Information Security Specialist Examination	For high-level IT professionals with specialized careers, who manage information security by realizing security functions in accordance with information security policies, or organizing infrastructures in the process of planning, defining, developing, managing, and maintaining information systems
11. Information Technology Service Manager Examination	For high-level IT professionals with specialized careers, who provide safe and reliable services by securing stable system operation and continuous improvement, controlling quality, and, in the event of failure, minimizing damage
13. Systems Auditor Examination	For high-level IT professionals with specialized careers, who comprehensively inspect and evaluate the risks and controls related to information or embedded systems, independent of inspected parties, and report inspection results including advice for improvement to senior management
Health Information Manager (private certification) (Japan Society of Health Information Manager, 2013)	A specialist who incorporates information technology into medical record management to improve the quality of health care services, safety control, and hospital management

*Microsoft Office Specialist, Japan Testing Association, Information-Technology Promotion Agency, Japan Society of Health Information Manager; there are a large number of official and private certification examinations.

provide remote medical care, and read X-ray films, electrocardiographic data, and radiation test results (Kohzaki, 2012b; Kohzaki et al., in press; Garg et al., 2011).

There has been notable progress in ICT, and its introduction to the field of medicine has yielded positive effects, such as significantly increasing efficiency and curbing medical expenses (Chaudhry et al., 2006). Furthermore, when introducing a medical information system, attention should not only be paid to its cost-effectiveness. It should also be ensured that all health care professionals can easily use the system (Suishu et al., 2000; Ohuchi et al., 2001; Kurihara et al., 2002; Nagai et al., 2004). It is essential for health care professionals, including nurses and medical technologists, to develop high ICT literacy. Institutions for training health care professionals should adopt curricula that include ICT literacy education for students, many of whom had not acquired ICT skills prior to graduating high school. In addition, it is important to ensure the quality of ICT education to facilitate smooth communication between physicians, nurses, and other health care professionals, and provide education on patient information exchange.

As the electronic medical chart system has become widely used, ICT is being introduced across Japan. Therefore, ICT literacy education will become even more important in the provision of advanced and useful medical information. In addition to automatic alarm systems for elderly people living alone (Shinagawa et al., 2006), progress in ICT will support telemedicine in sparsely populated areas with a shortage of physicians (Kurihara et al., 2000; Oba et al., 2006; IMIA, 2010).

In Japan, a rapidly aging society, medical expenses have been steadily increasing. It is certain that ICT will play an essential role in reducing medical expenses and streamlining health care services; therefore, knowledge of ICT is necessary for paramedics.

CONCLUSION

I have developed an ICT curriculum to effectively train paramedics and medical technologists in Japan and help them pass the national examination. However, as the ICT environment in health care institutions continues to improve rapidly, health care professionals, including paramedics and medical technologists, and students are required to continue their efforts to keep pace with its advancement.

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