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Radiography Education and Training in Saudi Arabia

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ABSTRACT

During the recent past, there have been considerable advancements in the radiologic techniques in the United States and European Countries. These techniques have been considered in Saudi Arabia, to keep pace in line with the latest developments in radiologic technology. Saudi radiographers are necessarily to be more professional with updated knowledge to meet the demands of modern times in the health sector. Therefore, radiologic technology education and training programs must be built to meet the uprising technology in health care. This paper presents the present state of affairs in this field in Saudi medical Institutions and medical training centers. It is concluded that advance radiographic techniques like digital imaging should be preferred in the curriculums of education and trainings.

Keywords: Radiography; Education; Saudi Arabia

1. Introduction

Since the introduction of x-ray imaging in 1900s, radiography has evolved rapidly into more complicated practice with a great deal of responsibilities and duties. As a result, there have been significant changes in radiography education and practice during the last two decades [1].

Radiography (also called radiologic technology) includes conventional x-ray imaging as well as additional imaging modalities such as fluoroscopy, mammography, ultrasound (US), computed tomography (CT), magnetic resonance imaging (MRI), nuclear medicines (NM) and radiation therapy (RT). Radiography is an essential diagnostic tool of modern medicine.

Treatment of a patient depends on the accurate and precise production of radiographic images and successful interpretation of these images. Various injuries and conditions can be treated when the exact diagnosis is known to the physician. Therefore, a radiographer must be well educated and trained to achieve this goal. A highly quailfied and skilled radiographer is a significant member of the health care staff. He could provide appropriate services using imaging techniques, and evaluates radiographs of technical quality.

A high-quality vocational program for radiographers, which produces competent radiographers for both diagnostic and radio therapeutic working environment, is the basis for the development of a radiographer's vocation [2]. With the current changes in the areas of radiology, it is necessary to enhance radiography educational standards to fulfill the needs of the health care community [3]. Therefore, it is necessary to review the status of radiography education and training in the third world and compare it with similar programs in the developed countries. The additional responsibilities of today's radiographer make it necessary to upgrade the educational programs to sufficiently educate students without overwhelming them in the process [3]. An ideal curriculum would offer multiple modalities that could be included more effectively in a baccalaureate degree programs. The future of the radiologic sciences depends to a large extent on the outcome of its education [4].

2. Background of Radiologic Technology Education and Training

In Saudi Arabia, radiologic technology education and training were introduced 50 years ago when Saudi radiology candidates were started sending to the USA and Europe for qualification either to obtain a baccalaureate degree or diploma. Radiologic technology education and training in Saudi Arabia started in 1960 by establishing short training programs for nurses organized by the Ministry of Health. After that, a two-year program was introduced in a number of Health Institutions in various cities. At the beginning, the educational entrance requirements to enter a course in radiography were based on national school certificates obtained normally at the age of 16 years. Twenty years later, high school graduate only are permitted to enroll in these health institutions.

During the last decade many of these two-year courses were converted into 3-year programs at the level of Intermediate Health Colleges. The main programs in these institutes and colleges were on the x-ray imaging.

The Saudi government realized the need for qualified graduate radiographers and in 1976, the academic education and training of radiologic technology was introduced. In this year the College of Applied Medical Sciences (CAMS) was established at King Saud University. Later on, more colleges were established in other Universities. This shows that radiologic technology education has been well established in Saudi Arabia. Female students are also admitted to such educational programs.

Furthermore, the private sector has also participated in establishment of more radiographic schools and colleges under the supervision of Ministry of Higher Education (MOHE) and the Ministry of Health (MOH). **Table 1** shows the number of governmental and private institutions that run radiologic technology programs and enrolled students. Presently, the total number of male and female students in radiographic schools and colleges is between 5500 and 6000. Baccalaureate and diploma students are between 2900 and 2700 respectively.

3. Admission and Selection Process of Interested Students

Generally, a few studies have assessed the consistency of admission standards in radiography programs [5]. In the United Kingdom, the educational requirements for the radiographer have already been elevated to a baccalaureate degree [6]. Although there is a great demand for higher education in radiologic technology, it far exceeds the available capacity within the country's Universities and Colleges. Thus, competition for radiologic technology programs in the Universities is really tough.

4. Radiologic Technology Curriculum

Rapid technological changes have made it increasingly difficult to define a common structure of education for the profession. In any curriculum, it is important to give students a solid foundation of traditional core knowledge besides providing opportunities to develop skills in various areas of radiologic technology. However, the knowledge and skills should provide students with all the core subjects required to meet the health professions body standards.

In Saudi Arabia, there are two types of radiologic technology programs: Baccalaureate-degree program, which lasts for 4 - 5 years and diploma-degree program, which lasts for two years. The radiography curriculum varies slight among the Saudi Universities. In this study, the curriculum of King Saud University will be reviewed being a founding University running such programs.

In general, the radiography curriculum of baccalaureate program consists of two major areas: general education and professional education. General education and training in radiography (35 - 40 hours) includes English language, culture, chemistry, organic chemistry, physics, biostatistics and zoology. General education and training requires one and half year full time study. It is designed to provide students with the basic knowledge for radiologic technology in addition to English language skills.

The curriculum of the professional education and training (95 - 100 hours) is shown in **Table 2**. The initial phase of the curriculum focuses on the basic sciences of diagnostic imaging, followed by concurrent clinical internships and class room lectures. The American Society of Radiologic Technologists (ASRT) sponsored a national educational consensus conference in radiologic sciences to define the roles and responsibilities of radiologic technologists at various educational levels [7]. Curricular content was suggested for the certificate or associate degree level which was designated for the technical/entry level and for the baccalaureate level which was designated the professional level (National Educational Consensus Conference, 1996). For the purpose of comparison, **Table 3** shows the curriculum produced by the American Society of Radiologic Technologists (ASRT). The headline syllabus of contents of ASRT has been illustrated so that it can be compared with the average content of Saudi college's curriculum. This is because sometimes two contents may have different titles but identical syllabus.

It is obvious that radiologic technology education and

Table 1. Educational institutions that offer radiographic programs in Saudi Arabia for the academic year 2007/2008.

Educational Center	Sector	No. of Colleges	Degree	Program Duration	No. of Students	Gender
Universities (CAMS)	MOHE	6	B.Sc.	4 - 5 years	700 - 800	M & F
Community Colleges	MOHE	4	Diploma	2 years	200 - 240	M & F
College of Health Science	MOH	10	B.Sc.	4 - 5 years	1800 - 2000	M & F
Health Institutes	MOH	37	Diploma	2 years	1500 - 1700	M & F
National Colleges	Private	3	B.Sc	4 - 5 years	200 - 300	M & F
National Institutes	Private	23	Diploma	2 years	500 - 600	M
National Institutes	Private	17	Diploma	2 years	300 - 400	F

Table 2. Curriculum of radiographic baccalaureate programs in Saudi Arabia (Total Credit Hours 135), compared with the American Society of Radiologic Technologists (ASRT) hours per week.

LEVEL 1	Course Category	Class Hours	Lab/Clinic Hours	Credit Hours	ASRT
English Language Course	General	6	1	6	
Arabic & Cultural Courses	General	4		4	
Biostatistics	General	2		2	
Total CR Hours				12	
LEVEL 2					
Medical Terminology	General	3		3	✓
General Chemistry	General	2		2	
Organic Chemistry	General	2		2	
General Physics	General	3	2	4	
Zoology	General	3	2	4	
Total CR Hours				15	
LEVEL 3					
Arabic & Cultural Courses	General	4		4	
Advanced Biostatistics	General	3		3	
Health Care System	General	3		3	✓
Basic Anatomy & Physiology	General	3	2	4	✓
Emergency Care	General	2	2	3	
Total CR Hours				17	
LEVEL 4					
Cultural Course	General	2		2	
Pathology	General	2	2	3	✓
x-Ray Physics	Major	2	2	3	✓
Radiography Anatomy	Major	2	2	3	
Radiography Physiology	Major	2	2	3	✓
Computers in Imaging	Major	2	2	3	✓
Total CR Hours				17	
LEVEL 5					
Cultural Course	General	2		2	
Basic Radiography Technique	Major	2	2	3	
Nuclear Medicine Physics	Major	2	2	3	
Radiography Clinical Practice	Major	2	2	3	✓
Image Recording & QC	Major	2	2	3	✓
Total CR Hours				14	
LEVEL 6					
Health Service Administration	Major	2		2	✓
Contrast Media Techniques	Major	2	2	3	✓
Fluoroscopic Techniques	Major	2	2	3	✓
Clinical Nuclear Medicine I	Major	2	2	3	
Radiotherapy I	Major	2	2	3	
Neurological Radiography Tech.	Major	2	2	3	
Total CR Hours				17	

Continued

LEVEL 7					
Ultrasound Physics	Major	2	2	3	
Techniques of Port & OR	Major	2	2	3	
Contrast Media Clinical Practice	Major	2	2	3	
Clinical Fluoroscopy	Major	2	2	3	✓
Radiation Protection	Major	2	2	3	
Total CR Hours				15	
LEVEL 8					
Advance Radiography Techniques	Major	2	2	3	
Accident & Emergencies	Major	2	2	3	
Clinical Port & OR	Major	2	2	2	
Clinical Ultrasound I	Major	2	2	3	
CT Imaging	Major	2	2	3	✓
Total CR Hours				14	
LEVEL 9					
Radiotherapy II	Major	2	2	3	
Interpretation of Films	Major	2	2	3	
Clinical Ultrasound II	Major	2	2	3	
MR Imaging	Major	2	2	3	
Clinical Nuclear Medicine II	Major	2	2	3	
Total CR Hours				15	
LEVEL 10					
Full-Time Practical Training in a Hospital	Major				

training in Saudi Arabia complies with the curriculum produced by the ASRT. Although they are taught as a chapter included in some subjects, four contents of ASRT are not taught separately as stand alone courses. Those are medical terminology, digital imaging, ethics and law in radiologic sciences and pharmacology. Furthermore, other important subjects should also be included in the Saudi education like introduction to sociology and psychology, hospital administration and advanced MRI imaging.

Professional education and training are designed to provide students with the knowledge base and environment to develop into radiologic technology field. Professional education and training in radiography are a combination of lectures, practical demonstration, procedural simulation, and actual clinical practice. The last two years of the curriculum are directed mostly toward the clinical practice. With the presence of qualified radiologists and radiographers, students will progress from observing to assisting and subsequently to conducting radiographic examinations. In this manner, they will immediately utilize the theories and concepts presented in the classroom. The clinical experience associated with the professional education and training portion of the program is conducted in the radiology departments of the hospitals where training is carried out. Supervised clinical education and training are essential part of the curriculum of all radiography programs. The integration between the clinical and basic sciences is progressive and proceeds with direct patient contact early in the curriculum.

Most of colleges are provided with laboratories equipped with modern equipments in physics, chemistry, anatomy, ultrasound, x-ray and fluoroscopy machines, image processing equipments and gamma camera. However, due to limited number of large hospitals in major cities, there is a difficulty in training and following up students individually. Diploma Institutions are equipped only with an x-ray machines and small physics and chemistry labs.

There are no Institutions specialized in the education and training of imaging modalities apart from x-ray imaging. Therefore, Saudi radiographers lack advanced education and skill in other imaging modalities such as: CT, MRI, nuclear medicine and radiation therapy. However, competence in modalities such as MRI, CT and nuclear medicine is obtained via on job training opportunities provided by employers as done in other countries [8].

Table 3. Radiography curriculum produced by the American Society of Radiologic Technologists (ASRT) in 2007.

Content	Headline Syllabus	CAMS KSU
Basic Principles of Computed Tomography	Computed Tomography Generations, Components, Operations and Processes, Radiation Protection	✓
Clinical Practice	Code of Ethics/Professional Behavior, Professional Communication, Role of Radiographer, Procedural Performance, Clinical Competency	✓
Digital Image Acquisition and Display	Basic Principles of Digital Radiography, Image Acquisition, Software Image Processing, Fundamental Principles of Exposure, Image Evaluation, Quality Assurance, Display	
Ethics and Law in the Radiologic Sciences	Ethics and Ethical Behavior, Ethical Issues in Health Care, Legal Issues, Patient Consent	
Fundamentals of Radiologic Science and Health Care	The Health Science Professions, The Health Care Environment, Hospital Organization, Radiology Organization, Accreditation, Regulatory Agencies, Professional Credentialing, Professional Organizations, Professional Development and Advancement	✓
Human Structure and Function	Cell Structure and Genetic Control, Metabolism, Tissues, Skeletal System, Muscular System, Nervous System, Endocrine System, Digestive System, Cardiovascular System, Lymphatic System, Respiratory System, Urinary System, Reproductive System	✓
Image Analysis	Imaging Standards, Image Appearance Characteristics, Procedural Factors, Corrective Action	✓
Imaging Equipment	x-Ray Circuit, Radiographic Equipment, Diagnostic x-Ray Tubes, Image Intensified, Fluoroscopy, Linear Tomography, Quality Management	✓
Medical Terminology	Medical Abbreviations and Symbols, Radiologic Technology Procedures and Terminology, Understanding Orders, Requests and Diagnostic Reports	
Patient Care in Radiologic Sciences	Radiographer and Health Care Team, Attitudes and Communication, Patient/Radiographer Interactions, Safety and Transfer Positioning, Evaluating Physical Needs, Infection Control, Medical Emergencies, Unique Situations and Trauma, Contrast Studies, Tubes, Catheters, Lines and Collection Devices, Mobile and Surgical Radiography	✓
Pharmacology and Drug Administration	Drug Nomenclature, Methods of Drug Classification, General Pharmacologic Principles, Five Rights of Drug Safety, Drug Categories of Relevance to Radiography, Classification of Contrast Agents, Routes of Drug Administration, Intravenous Drug Therapy	
Radiation Biology	Introduction, Biophysical Events, Radiation Effects, Radiosensitivity and Response	✓
Radiation Production and Characteristics	Structure of the Atom, Nature of Radiation, x-Ray Production, Interaction of Photons with Matter	✓
Radiation Protection	Introduction, Units, Detection and Measurement, Surveys, Regulatory/Advisory Agencies and Regulations, Personnel Monitoring, Application, Patient Protection	✓
Radiographic Pathology	Definitions/Terminology, Classifications, Causes of Disease, Radiologic Pathology	✓
Radiographic Procedures	Standard Terminology for Positioning and Projection, General Considerations, Patient Considerations, Positioning Considerations for Routine Radiographic Procedures, Procedural Considerations for Contrast Studies	✓
Film-Screen Image Acquisition and Processing	Image Appearance Standards, Optical Density, Contrast, Spatial Resolution, Distortion, Exposure Latitude, Beam-limiting Devices, Beam Filtration, Scattered and Secondary Radiation, Exposure Factors, Darkroom/Storage Environment, Image Receptors, Intensifying Screens, Automatic Processing , Artifacts	✓

The radiography curriculum of diploma program, general and profession education and training are illustrated in **Table 4**. It focuses on x-ray imaging only. However, there is a need to develop those radiographers with higher level skill basic radiography.

The teachers on radiologic technology education and training programs in Saudi Arabia were from different countries such as, India, Pakistan, Egypt, Sudan, Jordan. Nowadays, most of them are Saudis, who had got there higher education in Canada, United States, Germany and United Kingdom.

Radiologic technology education and training programs in Saudi Arabia offer a complete range of imaging studies including Digital Mammography, x-Ray, MRI/MRA, CT/CTA, PET/CT, Nuclear Medicine, Ultrasound, DEXA for bone density measurement, and more.

Advance healthcare standards through the design and regulation of post graduate training programs, the effective classification and registration of healthcare practitioners, and encourage research and continuing health professional development in the kingdom, through

Table 4. Curriculum of radiographic diploma programs in Saudi Arabia (Total Credit Hours 68).

LEVEL 1	Course Category	Class Hours	Lab/Clinic Hours	Credit Hours
English Language Course	General	2		2
General Biology	General	2	1	3
General Chemistry	General	2	1	3
Medical Terminology	General	1		1
Basic Principles of Computers	General	1	1	1
Culture	General	1		1
Total CR Hours				11
LEVEL 2				
Radiographic Anatomy	Major	2		3
Radiographic Physiology	Major	2		3
x-Ray Physics	Major	2	4	4
Image Recording Technique	Major	2	4	4
Total CR Hours				14
LEVEL 3				
Basic x-Ray Equipment and Safety	Major	2	4	4
Radiographic Technique I	Major	2	4	4
Radiographic Technique II	Major	2	4	4
Patient Care in Radiology Dept.	Major	2		3
Total CR Hours				15
LEVEL 4				
Radiographic Technique III	Major	2	4	4
Radiographic Technique IV	Major	2	4	4
Accidents and Emergency Radiog.	Major	2	4	4
Mobile Radiography	Major	2	4	4
Total CR Hours				16
LEVEL 5				
Reading Radiographic Images	Major	2	4	4
Clinical Practice	Major		17	8
Total CR Hours				12

partnership with local and international institutions.

Introducing and implementing postgraduate programmers for the purpose of increasing the quality of health care professionals in the Kingdom is a major goal and responsibility of the Saudi Commission for Health Specialties (SCFHS). SCFHS has adopted new regulations for the purpose of training and examinations in their programmers to reach that goal. SCFHS has also created specific regulations for accrediting training centres. This regulation plays an important role in measuring the level of government hospitals, private hospitals, and training centres' capacity to host programmers.

5. Certification and Employment Opportunities

Radiography programs at Saudi Universities offer two types of certifications: A baccalaureate degree or a diploma degree in Radiography. The baccalaureate degree is awarded when students complete 135 hours course work successfully. The diploma degree is awarded when students complete 68 hours course work successfully. Upon successful completion of the degree requirements, students are eligible to apply for a job corresponding to the type of their degree.

As a result of technological advances and the shortage of healthcare specialists in Saudi Arabia, employment opportunities for radiographers are on demand. Job opportunities are good due to the shortage of radiographers. Radiographers can choose to work in hospitals, clinics, primary health care centers and other medical or Industrial facilities running radiographic examinations. Career advancement opportunities exist in education, administration, and research and sales representatives. Furthermore, salaries for radiographers are competitive with other professionals with similar levels of education. Radiographers usually work independently or interact with other members of the health care team such as radiologists, surgeons, emergency medicine physicians, cardiologists, and nurses. Nevertheless, as in the United States and Norway, radiographers have struggled with the idea of serving as both assistant to the radiologist and patient advocate [9].

Careers of radiographers in the field of US, CT, MRI, CIT, nuclear medicines or radiation therapy is promising. Upon completion of a bachelor's degree, opportunities exist to continue education and obtain a master's degree. Such graduates in one of the radiologic technologies are desirable for supervisory, administrative or teaching positions.

6. Conclusion

The radiography curriculum in Saudi Arabia is at par with the curriculum produced by ASRT. It is also following the curriculum taught in many Universities in USA and Europe. Yet, digital imaging and radiation protection should be taught more thoroughly. Although there is a great demand for radiographers, hospital training availability should be considered. More emphasis should be given to CT, MRI and nuclear medicines. Educationists must reform teaching strategies, techniques and clinical training. Instructional delivery systems must be changed to accommodate the cultural diversity and different learning styles of the present day students [10].

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