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Development of an Integrated Ultrasound Curriculum for Medical Students

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ABSTRACT

The increasing use of ultrasound modality as the first line of investigation in critical situations has expanded its medical education potential. Ultrasound has become part of the curriculum for basic medical education in many schools. Despite the evolution of ultrasound technology, patient care may be negatively impacted by ultrasound if untrained or insufficiently trained individuals perform it. This study aims to provide evidence-based data regarding how a suitable integrated ultrasound curriculum can be incorporated and implemented within the undergraduate medical school. Theintegrated ultrasound curriculum (iUSC) hasbeen designedbasedontheneeds oftheSaudi communitytomeet the required competencies. The curriculum consisted of four years in addition to internship according to the Saudi regulations. The curriculum includes subjects, objectives, teaching methods, and evaluation methods. Particular emphasis was paid to stakeholders. Program assessment criteria based on the World Federation for Medical Education (WFME) accreditation criteria. The establishment of the integrated ultrasound curriculum (iUSC) is recommended for capacity building capable of using advanced ultrasound machines to diagnose a wide range of pathological conditions. The curriculum encouraged learners' self-education, independence, problem-solving, community-orientation and enhanced their ability to work effectively within a team.

Key words: Integrated ultrasound curriculum, Undergraduate students, Radiography, Medical education

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INTRODUCTION

Medical ultrasound features the usage of sound waves with a high frequency (ranging from 1.0 MHZ for the deep organs to 40 MHz for the high resolution images for superficial tissues) [1,2]. The reflected sound waves are converted into pictures of internal structures within the body, and may include blood-flow, tissue, and organs. In addition to that, ultrasound can be used to teach organs and tissue morphology, functions, and pathophysiology [3,4]. Ultrasound techniques include a vast array of interventional and diagnostic practices under a broad umbrella of medical procedures. The major drawback of ultrasound use is that to derive the most significant benefit from the procedure. The practitioner must have an extensive amount of experience with the apparatus - the expertise of the ultrasound user is known to be improved significantly as his utilization of the technique increases. The practice of ultrasound is expanding in clinical medicine, and consequently, there is an increasing demand for education and training [3,5].

The modern ultrasound scanner is becoming an essential diagnostic apparatus for furthermost medical specialties can extract pictures of anatomical structures in precise detail, and blood flows can be represented both in color in and in actual-time [3,6].

The expanding potential of ultrasound, due both to its increased portability and application within more medical spheres, has proceeded to the point where it is critical to widen the usage and training of ultrasound and for this be extended to the medical-school level[5,6].

Despite the evolution of ultrasound technology, patient care may be negatively impacted by ultrasound if untrained or insufficiently trained individuals perform it. The ultrasound scan is highly operator dependent, as the quality of images and accurate diagnosis is directly linked to the operator's skills and experience [7].

Therefore, incorporating clinical ultrasound applications in the medical school curriculum is justified due to the high sensitivity and specificity, wide availability of advanced ultrasound machines as a fast screening tool on the bedside has stimulated significant interest in the adoption of skills in ultrasound as a tool for focused bedside diagnosis and technical assistance during procedures [8]. Changes in the training of many medical disciplines now require participants to undertake medical ultrasound training to a clinically acceptable competence level. The radiology departments' resources cannot cope with the high demands of ultrasound investigations in different medical specialties, which may negatively impact patient care, particularly in critical care situations [9]. In addition to that, concurrent evidence has shown that point of interest ultrasound improved patient care quality and patient safety [7,10]. Previous studies showed that the emergency physician had a sensitivity of less than 70% [11,12]. Unfortunately, many medical specialties lack validation standard guidelines for their ultrasound training. There is a wide variation in the length of formal training and the number of scans required to be eligible to conduct an ultrasound examination independently. In addition to the training limitations and technical skills, the wide variety of professional backgrounds of those practicing in clinical ultrasound has led to a debate regarding the provisions of medical ultrasound services toward implementing point of care ultrasound. Brown et al[13] reported that over 90% of the medical students supported integrating ultrasound in the anatomy curriculum. Integrated ultrasound curriculum has been applied in about 200 medical schools. However, it varied in the type of curriculum and number of years. Sixty-three schools applied the curriculum in all fourth medical school years. Yet, despite the accumulative evidence and directional policies toward the point of interest ultrasound, guidelines and educational pathways to achieve competency levels have not become generalized. Furthermore, there is still a lack of standardized curricula, competency assessment, and teaching methods among multi-disciplinary medical specialties. Therefore, a sub-structure ordinary curriculum is required as a quality point of interest across medical disciplines[10,14].

Therefore. There is an imperative need to use clinical ultrasound applications to ideally be achieved through formalized and structured trainingschemestooptimizemedicalultrasounds' clinical value. None of the universities in Saudi Arabia have well-established frameworks to teach medical ultrasound at the undergraduate level. This study aims to provide evidence-based data concerning how a suitable integrated ultrasound curriculum can be incorporated and implemented within the undergraduate medical school.

MATERIALS AND METHODS

The curriculum

Thecurriculum hasbeendesignedbasedonthen eedsoftheSaudicommunitytomeetthechalleng esofeducatingcompetentdoctorsforthetwenty-first century,which includes: (i) Changes in the delivery of healthcare. Services are being moved away from in-patient hospital care towards day-care, out-patient clinics and community settings. Improved diagnostic techniques, and treatment methods, enhanced community services and government policy have contributed to this trend. (ii) An increasing emphasis on research-based practice, and (iii) Changes to the public's expectations of a doctor.

These key principles were developed to provide a frame work for the development and maintenance of aninte gratedultra sound curriculum for the undergraduate medical education curriculum.

Curriculum concepts

The core concepts of health and disease prevention are fully integrated into the curriculum.

a. Vertical integration of the curriculum will be implemented for scientific and hands-on clinical experience throughout all four years of their undergraduate medical education.

b. The American Institute of Ultrasound guidelines in Medicine (AIUM) in medical ultrasound will provide the curriculum's pedagogical basis.

c. The curriculum and its contents will be the Faculty's responsibility through the medium of the curriculum committee.

d. The curriculum will include Interdisciplinary/ Inter-professional education teams who will develop and implement the curriculum based on best practice in medical education, supported by the literature, our own experiences, and our colleagues' experiences. Additionally, student feedback will be reflected in the curriculum.

e. Learning will be fostered by weaving the scientific foundations of medicine and health with clinical experiences throughout the curriculum. These scientific foundations include basic science, clinical science, population-based science, and social and behavioural sciences.

f. The curriculum will provide three specifically designed transition courses for the students to ensure competence and readiness for the next stage of their professional education:

1. Transition to medical education at the beginning of the first year.
2. Transition to clerkships at the beginning of the third year.
3. Transition to graduate medical education at the end of the fourth year.

g. Students will be provided with an understanding of the Saudi community's health needs (including lower socio-economic populations) and the skills to improve the health of their patients and communities.

h. Recognition of the obligations of physicians to society-the central themes of public health, civic professionalism, teamwork and leadership are included in the curriculum.

i. The integrated system will place an emphasis on patient safety, quality medical care, and health-care delivery throughout the curriculum.

j. To encourage our students to become lifelong learners, problem solving and critical thinking in the practice of evidence-based medicine will be highlighted.

k. The curriculum will encourage all students to become medical scholars by providing them with the tools to evaluate and contribute to medical literature.

l. Students will acquire a core set of competencies in the knowledge and mastery of clinical skills and attitudes that are a pre-requisite to graduate medical education. These competencies are defined, learned and assessed, and serve as a mechanism for evaluation of the school's success.

Study guides will be used to facilitate learning

1. A range of educational strategies and learning methods will be utilized, including task-based and problem-oriented learning, community-based learning, and teaching and learning approaches that increasingly encourage students to adopt more responsibility for their education.
2. An 'assessment to a standard' approach which emphasizes the overall outcomes of the curriculum and which uses a range of methods including, but not limited to, online examinations, OSPEs, OSCEs (Objective Structured Clinical Examination), and portfolio assessment, which are to be completed in a timely fashion.
3. The curriculum's oversight and management will provide a systematic process that promotes open discourse and ensures continuous quality improvement.

Documents and other resources used for informing the proposed curriculum

Numerous medical schools have started to integrate ultrasound education into their curriculum. The integration of ultrasound at the University of South Carolina developed from 2006 to 2010.(Hoppmann, 2015).Several teaching methods and testing are used in the ultrasound curriculum during the first (M1) and second (M2) years of medical school. These methods include classroom lectures/demonstrations, a series of web-based learning modules, mandatory and voluntary laboratory sessions, written and web-based ultrasound questions, and objective structured clinical examinations (OSCE). The purpose of the curriculum is to make the learners active and community-oriented. After the significant expansion of the curriculum occurred and different lessons learned about the teaching of ultrasound to medical students, a nine-year review was also published. The

Ohio State University College of Medicine used current evidence-based practices to develop a vertical curriculum for focused ultrasound, which corresponded with the four-year medical school curriculum. In their curriculum, focused ultrasound was used to help students acquire an in-depth understanding of both clinical and basic science within the medical school curriculum. Their curriculum learning objectives included developing student understanding in indications for ultrasound use, proper image acquisition, interpretation of the ultrasound exam, and appropriate management of ultrasound findings.

Another valuable resource to assist in designing an appropriate ultrasound curriculum has been derived from the collaborative efforts of experts in radiology and medical education. Specialists from the Society of Radiologists in Ultrasound and the Alliance of Medical School Educators in Radiology have designed an ultrasound curriculum for medical students. Their article provides examples of how ultrasound can be incorporated either vertically or horizontally into a curriculum. The article also explains how their curriculum fulfills the Accreditation Council for Graduate Medical Education competencies[15].

Some academic medical studies illustrate that medical education often takes place in forums outside of the core curriculum. One setting for this is student-interest groups. The Ohio State University College of Medicine created a student-run organization, the Ultrasound Interest Group (USIG). With the mission of promoting ultrasound educational opportunities and student leadership across the medical school, they organized several scanning opportunities for students, sponsored different events. They created a vertical model of structured mentorship. The model for curriculum design we have chosen to adopt is inspired by the integrated ultrasound curriculum (iUSC)), applied in the School of Medicine at the University of South Carolina and operation for nine years[16]. We have modified the curriculum design to adapt to the College of Medicine curriculum requirements in King Saud Bin Abdulaziz University for Health Sciences. The following outline is how the curriculum will be delivered to KSAU students, how the students will be prepared for transition through the stages of their professional education, and the modes of assessment to gauge competencies.

RESULTS AND DISCUSSION

The curriculum outline

The curriculum (integrated ultrasound curriculum (iUSC)) will have a hybrid structure. Our pedagogical delivery will be based on lectures, hands-on laboratory sessions, small group learning (problem-based learning and clinic-pathologic sessions), and clinical experiences. All education material will be made available to students online throughout all four years: learning modules, videos, laboratory handouts, and notes. The curriculum will be integrated through all academic years of the course (four years). It will also be integrated and organized by a multi-disciplinary faculty. In the first semester of the first year, students will be instructed in the basics of ultrasound, emphasizing the physics and theory behind ultrasound technology's mechanism and how to identify the basic anatomical region. In the second semester of the first year, the curriculum will be focused on sonography application; the students will also be introduced to the concepts used to study circulation's physiology. In the second year, the main focus will be on enhancing the students' understanding of pathophysiology physical diagnosis. In the third year, the students will be starting their clinical rotations in different medical disciplines so that ultrasound education will be specified to those rotations. In the fourth year, the students will be supported by elective training programs in the field in which they are interested, as illustrated in Table 1.

Teaching methods

Ultrasound will be integrated into the current curriculum, which is divided into blocks. Each block will have a coordinator, co-coordinator, student coordinator, student-affairs coordinator, and responsible multi-disciplinary team. Each block's multi-disciplinary team should have a certified radiologist or an instructor with post-graduate qualifications in diagnostic ultrasound performance to assist the team with the block's ultra-sonographic content. The following teaching methods will be used, including lectures, simulation, video records and hands-on laboratory sessions, problem-based learning, and small group pathologic sessions.

Table 1: Suggested schematic in integration of ultrasound in medical school.

Year	Block	Content	Teacher	Instructional method	Milieu
M1	Foundation	Introduction to US	Expert	Lecture.	Lecture room
				Videos recordings	
	Musculoskeletal	Musculoskeletal Anatomy Ultrasound	Expert	Lecture	Lecture room
				Simulation	Simulation lab
				Videos recordings	
	Respiratory	Thorax Anatomy Ultrasound	Expert	Lecture	Lecture room
				Simulation	Simulation lab
				Videos recordings	
	Cardiovascular	Anatomy Ultrasound/ echo	Expert	Lecture	Lecture room
				Simulation	Simulation lab
				Videos recordings	
M2	Neuroscience	Anatomy Ultrasound Head, Spine	Expert	Lecture	Lecture room
				Simulation	Simulation lab
				Videos recordings	
	Endocrine	Anatomy Ultrasound	Expert	Lecture	Lecture room
				Simulation	Simulation lab
				Videos recordings	
	Urology & renal	Anatomy Ultrasound	Expert	Lecture	Lecture room
				Simulation	Simulation lab
				Videos recordings	
	Gastroenterology	Anatomy Ultrasound GIT, liver spleen, pancreas	Expert	Lecture	Lecture room
				Simulation	Simulation lab
				Videos recordings	
	Oncology	Pathology Ultrasound	Expert	Lecture.	Lecture room
				Videos recordings	Simulation lab
M3	Medicine	Ultrasound-Guided intravascular line insertion, Specialty-Based Hands- On Ultrasound	Expert	Lecture	Lecture room
				Simulation	Simulation lab
				Videos recordings	
	Surgery	Emergency Focused Ultrasound	Expert	Lecture	Lecture room
		Specialty-Based Hands-On Ultrasound		Simulation	Simulation lab
				Videos recordings	
M4	Family medicine	Specialty-Based Hands-On Ultrasound	Expert	Lecture	Lecture room
				Simulation	Simulation lab
				Videos recordings	
	Pediatrics	Specialty-Based Hands-On Ultrasound	Expert	Lecture	Lecture room
				Simulation	Simulation lab
				Videos recordings	
	OB & gynecology	Specialty-Based Hands-On Ultrasound	Expert	Lecture	Lecture room
				Simulation	Simulation lab
				Videos recordings	
	Special senses& mental health	Specialty-Based Hands-On Ultrasound	Expert	Lecture	Lecture room
				Simulation	Simulation lab
				Videos recordings	

Assessment

Quizzes

Quizzes are to be taken after the lectures to ensure the students' adequate comprehension and understanding.

Summative assessment

Year 1-2

At the end of the course, the students will have an examination consisting of:

1. A practical exam to be performed on live student models.
2. A written image identification examination to assess proficiency.
3. Objective Structured Practical Examinations (OSPE) sheet evaluated by sonography experts, including feedback after each simulation session as a continuous assessment tool.
4. Objective structured clinical examinations (OSCE) are administered at the end of the year.

Year 2-4

1. Objective structured clinical examinations (OSCE) are administered at the end of the year.
2. Portfolio.

Characteristics and abilities (competencies) of the KSAU graduate

The curriculum was designed to enable the graduate to assume roles as an expert in ultrasound technology, an excellent communicator, a professional medical practitioner, a life- long learner, have appropriate decision-making skills, and clinical reasoning and judgement. To achieve this, the graduates must develop and utilize the following competencies:

Medical knowledge

1. Apply the knowledge of biomedical, clinical, epidemiological, social, and behavioural sciences to improve patient care.
2. Have concrete knowledge of normal anatomy and disease processes.

Ultrasound specific knowledge

The graduate must have fundamental theoretical and practical skills in ultrasound including [17]. Specialty-Based Hands-On Ultrasound Experience.

i. Basics in Focused Ultrasound Protocols.
ii. Core Focused Ultrasound Protocols.
iii. Specialty-Based Hands-On Ultrasound Experience.
iv. Outlined in the Ultrasound Curriculum.
v. Pros and cons of ultrasound imaging to assess clinical problems.
vi. Accuracy of ultrasound for diagnosis of common diseases.
vii. of concepts of emergency sonography and able to perform hands-on procedural training on healthy volunteers [10,18].
viii. Ability to incorporate emergency sonography into daily clinical practice.

A medical student should demonstrate a commitment to carrying out professional responsibilities and an adherence to ethical principles. To achieve this, he must have the following competencies:

1. Demonstrate a commitment to carrying out professional duties and sensitivity towards a diverse patient population while adhering to ethical principles.
2. Accept the limits of their training for the use of ultrasound and the need for and utilization training for specialized ultrasound imaging.
3. During an ultrasound, an examination practitioner must demonstrate appropriate physician/patient interaction.
4. Recognize the importance of documentation and archiving images and their role in ensuring proper standards of care.
5. Realize the importance of timely communication of results, especially in the case of critical findings.
6. Recognize the importance of skills development by maintaining an accurate, up-to-date CME log.

Professionalism

Communication skills

i. The graduates should provide care that is safe, compassionate, and effective in diagnosis and management of common health problems.
ii. Have a positive demeanour and effective communication skills with patients, relatives, and colleagues.
iii. Express appropriate attitudes, possess ethical understanding, and understand legal responsibilities.
iv. Adopt an appropriate attitude to professional institutions and health.
v. Be able to effectively associate and exchange information with patients, their families and professional colleagues.

Decision-making and clinical-reasoning skills

This requires the physician to have developed abilities in

i. Clinical reasoning.
ii. Evidence-based medicine.
iii. Critical thinking.
iv. Research methodology.
v. Statistical understanding.
vi. Coping with uncertainty.
vii. Prioritization.

Improving patient-care practices

Investigation and evaluation are necessary to improve patient care practices. Appraisal and assimilation of scientific evidence are central to the achievement of these aims. KSAU graduates are expected to continually seek to improve

their knowledge and skills and apply this newly gained knowledge and skills in their daily practice. The skills required to attain those competencies are:

i. Use of evidence-based medicine (EBM).

ii. Adaptability to change.

iii. Personal time management.

Educational and learning objectives

As the bedside ultrasound procedures rapidly increased in different medical disciplines, there is a high demand for using ultrasound modality as a first investigation line on a daily clinical basis. Therefore, high-quality training and ultrasound education for future physicians has been a hot topic among medical schools and professional societies. Our integrated ultrasound curriculum passes through different stages with different learning objectives to achieve the curriculum goals.

Educational (learning) objectives

First year

Foundation Block (9 Weeks)

- ✓ At the end of the block, the students should be able to:
- ✓ Explain the basic ultrasound physics and principles.
- ✓ Describe the setup of ultrasound system.
- ✓ Differentiate various modes of ultrasound (A-mode, B-mode, M-mode, colour and Doppler).
- ✓ Correlate depth, frequency, and penetration to optimise image quality.
- ✓ Differentiate transducer types and their clinical use.
- ✓ Demonstrate correctly Image Orientation.
- ✓ Recognize on the ultrasound screen the positive and negative artefacts produced due to refraction, attenuation in addition to mirror artefact and reverberation.
- ✓ Identify sonographic anatomy of neck vessels.

Musculoskeletal sciences (8 weeks)

At the end of the block, the students should be able to:

- ✓ Differentiate ultrasound appearance of muscle, fat, tendon, nerve, blood vessel, and bone.
- ✓ Recognize on the ultrasound screen the sonographic appearance of the biceps tendon, acromioclavicular joint, subacromial-subdeltoid bursa, and infraspinatus teres minor.
- ✓ Identify on ultrasound screen sonographic appearance of patellar tendon, gastrocnemius, and soleus muscles.
- ✓ Evaluate hip dysplasia in a child by the diagnostic ultrasound machine.
- ✓ Demonstrate and measure an inguinal lymph node in long and short axis by using an ultrasound machine.
- ✓ Evaluate ultrasound finding of inguinal region hernia.

Respiratory sciences (7 weeks)

At the end of the block, the students should be able to:

- ✓ Identify on ultrasound screen the sonographic appearance of visceral and parietal pleura using 2 dimension and Motion-mode imaging.
- ✓ Identify on the ultrasound screen an A lines.
- ✓ Identify lung sliding with respiration by using diagnostic ultrasound machine.
- ✓ Use M-mode to identify normal lung pattern ("seashore sign") on ultrasound screen.
- ✓ Demonstrate the anatomical relationship of lung, diaphragm and liver/spleen and student should be able to differentiate all structures on ultrasound screen.
- ✓ Differentiate sonographic appearance of ribs, intercostal space, and pleural line.
- ✓ Evaluate common lung pathology: pneumothorax, pleural effusion, pulmonary oedema, and pneumonia by using diagnostic ultrasound machine.

Cardiovascular Sciences (6 weeks)

- ✓ At the end of the block, the students should be able to:
- ✓ Identify on the ultrasound screen the sonographic appearance of heart chambers and valves.
- ✓ Identify on the ultrasound screen fluid collection at the pericardium area.

- ✓ Demonstrate phases of cardiac cycle and valvar movements while performing echocardiography (sub-xiphoid four chamber view, Apical four chamber view, and parasternal short axis.
- ✓ Differentiate arterial and venous blood flow on the ultrasound screen.
- ✓ Measure peak systolic velocity, end diastolic velocity, pulsatility index, and resistance index by using diagnostic ultrasound machine
- ✓ Using M-mode to calculate a heart rat.

SECOND YEAR

Neurosciences (10 weeks)

At the end of the block, the students should be able to:

- ✓ List appropriate transducers for neurosonography procedures.
- ✓ Identify imaging artefacts encountered during neurosonography studies.
- ✓ Describe the sonographic planes that used in evaluation of the neonatal head.
- ✓ Identify the sonographic appearance and imaging planes of the neonatal and spinal cord.
- ✓ Explain the measurement techniques and determine normal dimensions for neonate head structures by using diagnostic ultrasound machine.
- ✓ Demonstrate appropriate use of duplex colour techniques.

Endocrine (8 weeks)

At the end of this block, the students should be able to:

- ✓ Identify sonogram abbreviations and the key words related to the thyroid, parathyroid and neck anatomy.
- ✓ Identify on the ultrasound screen the gross and sectional plane thyroid gland anatomy.
- ✓ Differentiate between normal and abnormal thyroid appearance as documented on a sonographic evaluation.
- ✓ Describe the sonographic imaging techniques to evaluate the parathyroid gland.
- ✓ Differentiate ultrasound appearance of cystic and solid mass.
- ✓ Discuss the advantages and limitations of sonographic imaging to evaluate thyroid and parathyroid gland.

Urology and Renal (5weeks)

At the end of this block, the students should be able to:

- ✓ Choose the appropriate machine setting and the correct probe to optimise quality of ultrasound imaging of kidneys, bladder, scrotum and prostate.
- ✓ Demonstrate and measure on the ultrasound screen the long and short axis of each kidney.
- ✓ Differentiate sonographic appearance of capsule, cortex, renal pyramid, and pelvis of the kidney.
- ✓ Perform scrotum ultrasound scanning.
- ✓ Estimate the bladder volume and use power flow Doppler to assess bladder jets.
- ✓ Measure the prostate gland volume using transabdominal and endorectal probes.
- ✓ Identify on the ultrasound screen the most common abnormal findings of the kidney, bladder, scrotum and prostate.

Gastroenterology (6 weeks)

At the end of this block, the students should be able to:

- ✓ Choose the appropriate machine setting and the correct probe to assess the hepatobiliary system by using diagnostic ultrasound machine.
- ✓ Demonstrate on the ultrasound screen the liver lobes and segments using subcostal and intercostal view.
- ✓ Demonstrate on the ultrasound screen the IVC, portal vein, hepatic veins and hepatic artery.
- ✓ Demonstrate on the ultrasound screen the gall bladder body and neck in long and short axis.
- ✓ Measure the common bile duct by using the diagnostic ultrasound machine.
- ✓ Measure long and short axis of the spleen by using the diagnostic ultrasound machine.

THIRD YEAR

Medicine 1 (9 weeks)

- ✓ At the end of this block, the students should be able to:

- ✓ Set up equipment and choose the correct position for central line placement for intravenous access under ultrasound guidance.
- ✓ Evaluate the possible ultrasound difficulties with guided of central line placement.
- ✓ List the Procedural steps involved in locating, accessing and cannulating the internal jugular vein with ultrasound guidance.
- ✓ Evaluate the gastrointestinal, hepatology and nephrology tracts as part of physical examination by using the handheld ultrasound probe.

Medicine 2 (9 weeks)

At the end of this block, the students should be able to:

- ✓ Perform echocardiography of the heart chambers through the following windows: Parasternal long axis view, Parasternal short axis view, Apical 4 chamber (+/- Apical 2 chamber) Subcostal view (including IVC view).
- ✓ Assess the pathological finding of Right and Left ventricles (dilatation, impairment) by using diagnostic ultrasound machine.
- ✓ Assess the pericardial fluid by using diagnostic ultrasound machine.
- ✓ Assess hypovolaemic cases by using diagnostic ultrasound machine.

Surgery (18 weeks)

At the end of this block, the students should be able to:

- ✓ Explain the indications for a FAST scan.
- ✓ Demonstrate Morisons pouch, the spleno-renal space, the pelvic cavity, the pericardial sac and the pleural cavity on the ultrasound screen.
- ✓ Evaluate ultrasound appearance of free fluid in upper and lower abdominal area.
- ✓ Perform Focused ultrasound examination of Trauma patient (FAST) with abdominal injuries.
- ✓ Detect gall bladder stones and Common bile duct obstruction by using diagnostic ultrasound machine.
- ✓ Evaluate sonographic findings of deep venous thrombosis.
- ✓ Evaluate sonographic findings of acute appendicitis.
- ✓ Describe advantages and limitations of ultrasound, compared to other imaging modalities.

FOURTH YEAR

Family and Community Medicine (9 weeks)

At the end of this block, the students should be able to:

- ✓ Evaluatethe Abdominal Aortic Aneurysm (AAA) by using diagnostic ultrasound machine.
- ✓ Perform ultrasound scanning of abdominal, pelvis and thyroid the handheld ultrasound machine on daily basis investigations.
- ✓ Detect gall bladder stones and Common bile duct obstruction on the ultrasound screen.
- ✓ Evaluate sonographic findings of deep venous thrombosis.

Paediatrics (9 weeks)

At the end of this block, the students should be able to:

- ✓ Specify the transducer, modality, and imaging optimization for different ultrasound procedures used to assess for neonate-infant brain and spinal cord.
- ✓ Evaluate head ultrasound pathology of neonate head.
- ✓ Assess pyloric stenosis in paediatric practice by using diagnostic ultrasound machine.
- ✓ Evaluate paediatric intestinal obstructions by using diagnostic ultrasound machine.
- ✓ Evaluate paediatric hip dislocation by Using diagnostic ultrasound machine.

Obstetrics & gynaecology (9 weeks)

At the end of this block, the students should be able to:

- ✓ Choose the appropriate machine setting and the correct probe for uterus ultrasound scanning.
- ✓ Perform transabdominal uterus sonography.
- ✓ Utilize M-mode to document fetal heart rate.
- ✓ A video clip sweep of the uterus on the ultrasound screen.

- ✓ Perform an obstetrical ultrasound including documentation of fetal number, heart rate and placenta locations.
- ✓ Determine the fetal location by using diagnostic ultrasound machine.

Teaching and instructional methods

In our integrated ultrasound curriculum, we are suggesting teaching and learning method, which composes of adult-based learning strategies like PBL along with other methods like interactive lectures or presentations, clinical teaching, demonstrations and simulation. This educational delivery method been kept in mind to integrate the affective, cognitive, and also the psychosocial domain .As we know that the reason most adults enter any learning experience is need oriented and also to create change. This change can be in their skills, behaviour, knowledge level or even attitudes about things. Adult learning principles were first described by Malcolm Knowles who described adult learning as self-directed inquiry and identified five characteristics of adult learning[19].These principles are described as 1.self- concept 2.Experience 3.Readiness 4.Orientation and 5.Motivation.Educational methods are applied in such a way that it helps the student to retain and absorb the information .Here we will like to elaborate on the teaching and learning methods. The teaching methods includes problem based learning (PBL), Interactive Lectures or presentations, Films and video records, Small Group learning and laboratory.

Curriculum implementation and management

Curriculum implementation plan has different elements includes

Temporal frame to implement ultrasound curriculum

The ultrasound curriculum will be integrated across four years following the introductory program of the college. Our ultrasound curriculum will be implemented at the medical school in King Saud bin AbdulAziz University for health sciences based on medical discipline blocks. The basic principles and physics requirements will be introduced at the foundation stage of the first year. Then every medical ultrasound applications will be added accordingly to the block speciality and working closely with clinical rotations directors. However, it is required to attend interactive lectures that will be given by certified radiologist or an expert with post graduate certificate/ degree on diagnostic ultrasound performance in lecture rooms or an auditorium. Two conducted hours as interactive lectures are required for each assigned block. Simulation with high fidelity phantoms and hands-on laboratory will be available throughout their study among four years.

Physical requirements

Our college currently has state of art simulation centre with high fidelity medical phantoms which may be used to teach students many medial ultrasound applications. Many ultrasound machines with different types of transducer could be provided to the ultrasound lab from the old vision machines in cardiac, medical imaging and Emergency department in king AbdulAziz Medical City, Riyadh.

Organization requirements for ultrasound curriculum

While planning and establishing the integrated ultrasound curriculum (iUSC), it has in essence to involve the organizational requirements of the integrated ultrasound curriculum which can be described as follows:

Involving the stakeholders in the program development

When developing a curriculum, it's important that there is a partnership between the educational sector (those who educate and produce human resources), and the health sector (those who will utilize those resources). This partnership will eliminate any isolation from the health system. Form the early stages of establishing and developing the curriculum, the health service staff and their representatives should have an active role in the planning committee, there also should be open channels of communication within the health system.

Also the founding dean should pay frequent visits to the high officials of the health ministry, to acquaint them with program and its philosophy and to update them on the development of the curriculum and ask them for their advice.

Forming a small committee which will be entrusted with implementing the curriculum (faculty planning group/foundation committee)

Curriculum development always begins at the level of the curriculum committee [20]. The group will consist of 5-9 members, in addition to the Dean and faculty that are expected to take part

in the curriculum faculty; the committee should include health services staff representatives and other health related sectors [21].

Political-legal

King Saud bin Abdulaziz University for Health Sciences, college of medicine established by royal decree in January 2004. The initial programme based on three essential curricula and one logical additional to have the final theme, includes problem-based learning, graduate medical programme, electronically enhanced curriculum delivery and hybrid balance. The 1st strategic goal for the university is to provide an outstanding learning environment that enhances the lives of undergraduate students and help them to be ideal healthcare professionals with multiple competences. For that reason, the university give more attention on curriculum planning and designing by many ways including full utilization of innovative curricula, periodic renewal of curricula and giving merits on curriculum development for the multidiscipline curriculum team.

Our integrated curriculum (a course plan, a study guide, a course description, and a description of programmes) will be presented to the curriculum committee. The curriculum committee has the responsibility and authority for planning and implementing the curriculum to insure meeting the required goals and objectives. Our integrated curriculum must be assessed and evaluated by curriculum committee. The complete proposed course plan and its contents will be distributed to all departments to ensure contribution and getting their feedback and approval. After that, the complete proposed course plan and its contents must be submitted to the Dean and College Council for approval.

Economic issues

Before implementing the ultrasound curriculum, we must consider both opportunity costs and financial support. The new curriculum will be implemented at the college of medicine in King Saud Bin Abdulaziz University for Health Sciences, where basic and advanced requirements are available such as classrooms, simulation labs, and portable ultrasound devices. In addition to financial support, permission must be obtained from different block coordinators to allocate the ultrasound curriculum in their respective blocks. This might contribute to additional costs by adding more learning objectives and prolonging the length of some blocks. Redeploying some of the old ultrasound machines for training might help reduce the cost of implementation. Costs for staff, including curriculum directors, coordinators, faculty, administrative personnel, and others, should also be considered. Compensation will be based on calculating the percentage of time dedicated to curricular activities comparative to full-time equivalent [22]. Using the Educational Value Unit as a method helps to quantify the effort educators put into curricular activities. Calculating educational value units can consider factors like the quality of teaching, learner level, the complexity of faculty expertise, and the activity's time [23].

Personal

The teaching staff of the integrated ultrasound sessions should be prevailed to perform and interpret ultrasound images. Certified radiologists, interventional radiologists, and clinicians certified with post graduate degrees to perform and interpret ultrasound, such as emergency, intensive care, and obstetrics physicians. Assisting and supervising the students in the skill lab and simulation labs can be done by ultrasound technicians. Administrative support personal needed such as secretary and student’s affairs assistant. Consider motivation, deficiencies in prior knowledge, etc.: what type of faculty development program would be required?

Cultural

Teaching ultrasound performance which is an intervention that will be done on patients or simulated patients, it has to emphasis on the respect of patient dignity and special cultural background of our community as Saudis Arabs and Muslims, to respect the patient privacy and respect human body not to expose more than the part needed for the procedure. And also, respect the patient's right if the female patient requested a female student and vice versa.

Assessment

The assessment provides feedback and guidance to students on their learning; it also provides feedback to faculty on the curriculum's success in achieving competency outcomes and offers evidence that students have achieved the minimum progress required

[24-27]. In our ultrasound curriculum we will provide student assessment by providing formative and summative evaluations by several methods including Objective structured clinical examination (OSCE),Objective Structural Practical Examination (OSPE), Student's attempts on Video Record Evaluation, Simulation-based assessment, multiple choice ultrasound questions as part of regular course examinations and other miscellaneous methods such as image interpretation during practical examinations, image review from ultrasound laboratory sessions, and Preceptor feedback during ultrasound laboratory sessions or Small group preceptor evaluation [16].

Evaluation

The current medical school curriculum in King Saud Bin Abdulaziz for Health Sciences was evaluated by World Federation for Medical Education (WFME) in April 2009. The medical school set a process for Program evaluation that investigates curriculum and students' progress. The final report of the WFME found that the standard set is fulfilled. Program evaluation is an ongoing process to address the educational process's context, the curriculum's specific items, the general outcome, and its social accountability. Our integrated curriculum will be evaluated by differentials [25-27], including program monitoring and evaluation, teacher and student feedback, students and graduates' performance, stakeholders, and external assessment.

CONCLUSIONS

Physicians' medical ultrasound is a new approach to patient evaluation and management in both acute and chronic settings. For many years, radiologists, sonographers, obstetric-gynecologists, and cardiologists have operated within the comprehensive ultrasound model. An ultrasound examination is performed, followed by an image evaluation by the physician. However, due to the availability of portable and handheld ultrasound machines, there has been a rapid growth in focused ultrasonography. The study showed that the curriculum is successfully designed to meet the operator's competency and experiences' current challenges. The study provided clear guidelines for initiating an ultrasound program according to Saudi Arabia's experiences from teaching medical ultrasonography.

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