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A Systematic Review of the Integration of Ultrasound into Medical School Curriculum

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Abstract

The use of ultrasound imaging has been quite beneficial in the medical field especially in diagnosing a wide range of conditions affecting different systems in the human body. It enables medical practitioners to view the inside of a human, ranging from various organs and tissues to a growing fetus. It is therefore important for medical students to have the adequate knowledge on the use and interpretation of ultrasound imaging and this should be incorporated in the curriculum all through the years in medical school. Therefore, the aim of this research is to analyse the benefits of introducing ultrasound through the years of medical school in order to facilitate proper acquisition of ultrasound technique by the students.

We searched various databases such as Medline and EBSCO for articles that discussed the teaching of ultrasound in medical schools. We reviewed 12 articles from 2008-2015 that described the teaching of the use and interpretation of ultrasound, its incorporation into different subjects and into the medical school curriculum. We compiled our findings, identifying the key benefits of teaching ultrasound in medical school and how medical students agreed that the knowledge of ultrasound and its continuous teaching all through medical school contributed greatly to their medical education.

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We identified different ways ultrasound was being taught in medical schools and the feedback of medical students concerning what was learnt. From the articles we reviewed, different teaching methods were identified and most institutions used surveys to get feedback from students. The feedback yielded mostly positive results as the students showed eagerness to learn and participate more in ultrasound based learning. It was also shown to have enhanced their knowledge of courses like Anatomy, Pathology and Physiology amongst others.

It is of great benefit to teach ultrasound to students all through medical school. It will not only boost the confidence of the students in being able to identify the normal from the abnormal while viewing the inside of a human body, but also prepare them for any challenges they will face in their clinical practice especially while handling ultrasound investigated cases.

***Keywords**:* Ultrasound; Medical school; Curriculum; Teaching; Integration; Medical education; All Saints University School of Medicine; Dominica; Systematic Review.

1. Introduction

Ultrasonography involves the use of sound waves at frequencies higher than the upper audible limit of human hearing. It is a diagnostic medical imaging technique used to view muscles, tendons, and internal organs, to visualize their size, structure and any pathology with real time tomographic images. Ultrasound is also used to observe growing fetus during routine and emergency prenatal care. Ultrasound is also increasingly being used in trauma and is fast becoming a staple of most emergency response teams.

The application of Ultrasound in the medical field started in the 1950's and has had growing relevance in medical diagnostics. Ultrasound was first introduced in Obstetrics, and subsequently in all other fields of medicine including Cardiology, Ophthalmology, Orthopaedics, Anaesthesia, Paediatrics, Radiology and so on [1]. When compared to the use of MRI's and CT scans, ultrasonography is less expensive, ensures patients comfort as the patient does not necessarily have to be moved around a scanner, and has no radiation exposure, therefore is the best choice for obstetric sonography. The advantages of ultrasound in modern medicine greatly outweigh all the risk.

The medical world is evolving every day and expectations of patients and medical students are increasing, therefore schools are kept on their feet to meet up with the expectations and close the gap between basic and clinical sciences. New innovations, constant remodelling and teaching techniques are being looked out for to make medical school more efficient and flexible, thereby preparing doctors that are capable of giving the best service to their patients and communities [2].

Quite a number of studies and experiments have been done to document the rising interest in the use of ultrasound as a support tool in teaching both basic and clinical sciences. The ultrasound has been useful in several teaching domains: study of the anatomy and function of abdominal organs, cardiovascular and musculoskeletal systems and also in teaching basic elements of physical examination [1,2].

However, even with the increasing relevance of ultrasound in medicine, teaching of clinical ultrasound imaging

in medical education is limited mainly to an optional year 4 elective and residency level training programs, and not basic medical sciences in medical schools [1]. Recently, there has been a rising need to integrate ultrasound training into medical school curriculum, although the available space in the curriculum is in question [1]. The medical faculties and students have raised concerns about the increased work load on students on an already cumbersome medical curriculum.

A few schools however have recorded successful implementation of ultrasound technique in the first year of medical school, these are included in organ based systems like anatomic dissections and physical examination laboratory sessions [1]. Previous research suggests that teaching ultrasound in medical school curricula is effective in achieving adequate student learning, acquisition and interpretation of medical imaging.

However, radiologists feel the teaching of ultrasound gives medical students too much confidence during their rotations/residency while handling ultrasound equipments even though they learn just the basics and are not fully skilled in the use of ultrasound. The work of the radiologist cannot be over emphasized as they are the trained specialists in the handling of imaging equipments [3].

The aim of our study is to evaluate the effectiveness of implementing clinical ultrasound into teaching in medical schools in all semesters, via diverse research sample results [1].

2. Materials and method

We obtained a variety of research work previously done on this topic and we analyzed them while taking note of the objectives, the methods used to obtain the data and also, the general conclusion. With the assistance of our research analysts, we searched MEDLINE and EBSCO databases using the search phrases: “Introduction of ultrasound in medical school”; “Benefits of having the knowledge of ultrasound throughout medical school” and “Integrating ultrasound into medical schools”; We retrieved 12 articles published from 2008-2015 and reviewed the full text of each article and compiled the article based on the following components: benefits and disadvantages of the use of ultrasound in medical schools, methods of assessment and teaching modalities. We sent it to our research analysts for further review and editing.

3. Results

The review of articles described different methods of ultrasound teaching and evaluation of students. Some teaching methods adopted the use of multiple teaching techniques and assessment modalities including lectures and demonstrations, required and open laboratory sessions and web-based learning modules. The analyses of teaching methods were done from student testing and on-line survey that were conducted at the end of each semester in addition to periodic focus groups which were held with the students to foster a sense of student partnership with the program. Some adopted an organ system teaching method after which anonymous and voluntary evaluations were administered. Some adopted the method of training students as simulated ultrasound patients for hands-on scanning sessions where students receive a longitudinal instructive and hands-on ultrasound education and some adopted the method of teaching ultrasound with specific subjects like anatomy. Most students reported back that the knowledge of ultrasound enhanced their medical education, helped them

prepare for challenges, increased their eagerness to participate in more ultrasound-based learning, and that this early exposure to the knowledge while in medical school will prime them for later encounters with ultrasound during clinical practice (Table 1).

Table 1: Data report for the ultrasound teaching method, semester taught and student's assessment method used within the past few years

Source	**Ultrasound Teaching Method**	**Semester/Subject taught**	**Method of student assessment**
Vi Am Dinh et al, (2015). [1]	Classroom lectures.	Year 1 and year 2 medical students	Ultrasound Objective Structured Clinical Examination (US-OSCE)
Petru-Adrian Mircea et al (2012) [2]	One on one practice sessions for first year medical students using ultrasound. Experimental teaching module of the anatomy, which included the simultaneous ultrasound visualisation of the same areas (1^{st} – 6^{th}year students).	1^{st} – 6^{th} year medical students.	Interactive techniques, student surveys.
Emily M. Webb et al (2014). [3]	Small-group teaching sessions that includes hands-on interactive instruction.	Preclinical medical students.	Voluntary online survey before starting the program and after the sessions.
Hoppmann et al. (2015). [4]	Online-based narrated modules, Videos, Online laboratory handouts, Voluntary ultrasound lab sessions – hands on experience using ultrasound mannequin	1^{st} - 4^{th} year of medical school.	Review on images using the pocket ultrasound devices, research projects presentations, MCQs, Image interpretation in practical examinations, Small group preceptor evaluation, image review from ultrasound lab sessions, OSCE
David Bahner, Nelson A Royall. (2012).[5]	Instructive lectures, video lectures, journal club sessions, hands on training-twice a month, scanning sessions on live student models.	Fourth year medical students.	Monthly quizzes based on instructive lectures on an ultrasound, monthly journal club quizzes, attendance, final practical and written exam, and written course project summary.
David P Bahner et al (2013). [6]	Real-time ultrasound images and videos, and focused ultrasonography.	1^{st} – 4^{th} year of medical school.	Post-course Practical and written examinations. Online quizzes and student survey.
Petrut	Basic ultrasound seminars,	Individual Pilot	Objective Structured Clinical

Gogalniceanu et al (2010). [7]	Practical demonstrations, Case-based discussions, Problem-solving exercises.	course: Year 3 and Year 5 medical students	Examination (OSCE), Questionnaires.
J. Matthew Blickendorf, et al 2014.[8]	Hands-on scanning sessions using medical students as trained simulated ultrasound patients (TSUP)	All year students with focus on Second year medical students	Certificate of participation if they volunteer at least 10 hours per academic year and attended required hands on sessions.
Richard A. Hoppmann et al. 2011.[9]	Classroom lectures/demonstrations, web-based learning modules, required laboratory sessions, voluntary open laboratory sessions.	All 4 years of medical school	Written and web-based ultrasound questions, and objective structured clinical examinations (OSCE) using standard patients (i.e. paid models taught to simulate patients and evaluate students).
Meenakshi Swamy and Roger F Searle. (2012). [10]	Anatomy practical dissecting sessions.	Second year medical students	Anonymous Questionnaire survey
Sishir Rao BA, et al (2008) [11]	Organ-system sessions	First year medical students	Two evaluations; anonymous through survey and voluntary evaluations by applying ultrasound techniques.

A study conducted by Petru-Adrian Mircea *et al* on the effect of introduction of ultrasound into their curriculum in both basic and clinical sciences, revealed encouraging results. 83% of the students gave a positive account of experience and 91% stated that it would be beneficial if it is taught throughout the 4 years of medical school [11]. Another study collating diagnostic accuracy by using hand-carried units (HCU) by undergraduate students with that of cardiologists showed that students identified correctly 78% of true pathological elements while cardiologists identified correctly 49% [12].

4. Discussion

As outlined in Table 1 a wide range of teaching modalities were used in different institutions. Teaching methods ranged from ultrasound integration into anatomy lectures, didactic lectures, videos, structured and open laboratory sessions, to student modelling as patients to mention a few.

These various teaching method were adopted to pass on relevant medical ultrasound knowledge to students. A possible review or further research can be done to figure out the best ultrasound teaching method.

Out of the 11 articles we reviewed, 8 of them included the use of ultrasound in more than one year of medical school, while the remaining 3 had ultrasound in just a year of medical school. However, the results showed most

students that had ultrasound taught in all the years in medical school had better knowledge of the use of ultrasound and its application in their various courses. This was most likely due to the fact that continuous exposure to the ultrasound technique sharpened their ultrasound skills and application in clinical knowledge. Re-enforcing ultrasound education frequently in all semesters also helped to promote retention of what was taught, thus enhancing their knowledge and also boosting the confidence of the students in applying the skill.

In schools where ultrasound education was limited to certain classes, students gave feedback and majority agreed that they would benefit from a continued ultrasound education [11]. Early exposure was also found to be helpful in future clinical practice [10]. At schools where ultrasound was taught throughout all the years, students agreed that ultrasound education was beneficial throughout the four years, and that it enhanced their medical education [9, 4].

For some students who were taught in year 3 and 5 only, they agreed that ultrasound should be taught in the undergraduate curricula [7]. We think this opinion of the students is probably due to their desire to obtain a pre-knowledge of the basic concepts of ultrasound. This is because integrating ultrasound only in the 3rd and 5th years of medical school not only gives them a shorter time to grasp the proper knowledge of the use of ultrasound, but also reduces their exposure to the accurate step by step application of the skill in the basic courses like anatomy, physiology, etc., as compared to students who were exposed to ultrasound right from their first year. In some schools where ultrasound was already integrated into all 4 years, about 75% of students agreed that more ultrasound can be integrated into the curriculum, this can help dissolve the argument that students are not capable to handle the extra curriculum. Knowing that proper and accurate physical examination is one of the most important aspects of a physician's eventual diagnosis and treatment, it is vital, that doctors get it right. Students found that ultrasound greatly enhanced their physical examination skills [4].

Ultrasound training at any level is always beneficial. Preclinical students found that after training they could better identify abdominal organs and they also found it to be educationally valuable [3]. However, continuous learning through all the years of medical school may be more beneficial. Students have given positive feedback on its integration and that it has greatly boosted their physical examination and diagnostic skills, clerkship and residency experiences and their medical education as a whole.

5. Conclusion

Consistent exposure to ultrasound from the 1st year gives educators ample time to teach a wide range of ultrasound techniques without it being cumbersome for students. As opposed to a one-year integration where students are more likely to forget the skills they have been taught and may not appreciate the full benefits of learning ultrasound. Therefore, we would suggest that ultrasound be taught in all the years of medical school as it will not only improve the student's grades but also enhance their clinical reasoning skills.

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