Improving Medical Students' Application of Knowledge and Clinical Decision-Making Through a Porcine-Based Integrated Cardiac Basic Science Program

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OBJECTIVE: Despite the concerted effort of modern undergraduate curriculum designers, the ability to integrate basic sciences in clinical rotations is an ongoing problem in medical education. Students and newly qualified doctors themselves report worry about the effect this has on their clinical performance. There are examples in the literature to support development of attempts at integrating such aspects, but this "vertical integration" has proven to be difficult. We designed an expert-led integrated program using dissection of porcine hearts to improve the use of cardiac basic sciences in clinical medical students' decision-making processes. To our knowledge, this is the first time in the United Kingdom that an animal model has been used to teach undergraduate clinical anatomy to medical students to direct wider application of knowledge.

METHODS: Action research methodology was used to evaluate the local curriculum and assess learners needs, and the agreed teaching outcomes, methods, and delivery outline were established. A total of 18 students in the clinical years of their degree program attended, completing precourse and postcourse multichoice questions examinations and questionnaires to assess learners' development.

RESULTS: Student's knowledge scores improved by 17.5% ($p = 0.01$; students *t*-test). Students also felt more confident at applying underlying knowledge to decision-making and diagnosis in clinical medicine. An expert teacher (consultant surgeon) was seen as beneficial to students' understanding and appreciation.

CONCLUSIONS: This study outlines how the development of a teaching intervention using porcine-based methods successfully improved both student's knowledge and application of cardiac basic sciences. We recommend that clinicians fully engage with integrating previously learnt underlying sciences to aid students in developing decision-making and diagnostic skills as well as a deeper approach to learning. (J Surg Ed 73:675-681. © 2016 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: clinical anatomy, application, cardiac sciences, clinical decision-making, cardiothoracic surgery

COMPETENCIES: Medical Knowledge, Practice-Based Learning and Improvement, Systems-Based Practice

INTRODUCTION

Anatomy has traditionally been considered the fundamental component of medical education and the importance of knowledge in anatomy in all aspects of clinical practice is well recognized. Despite this, modern curriculums are increasingly dedicating less time to its formal teaching.[1,2] Modern curriculums are increasingly using the principles of "horizontal" and "vertical" integration, where basic science disciplines are taught both within the context of each other and their clinical counterparts.[3] The aim of vertical integration is to allow transfer of knowledge from one context to

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another and allow students to apply their knowledge to clinical medicine. However, there are numerous examples within the literature suggesting that this has been difficult to truly achieve[4,5] with a transfer of knowledge from classroom to clinic only occurring in approximately 10% to 30% of the time.[6] Moreover, students and newly qualified doctors report feeling deficient in respect of their anatomical knowledge and worry that this may have an effect on patient safety.[7] They also report a lack of confidence in situations where application of anatomical knowledge is critical, such as surgery.[8-13] Adult learning theories suggest that learning is enhanced when an individual is able to refer to previous experience. This relies on previously obtained knowledge being consolidated during review of new material.[14-16]

Although basic anatomy teaching time has decreased, other factors may be adversely affecting on the quality of teaching available.[17] These include teaching that is provided by non-medically qualified individuals, decreased use of dissection as a teaching tool, and an inability to demonstrate clinical relevance during basic science teaching.[18] Teaching, that is, unable to demonstrate relevant clinical application is generally viewed as an obstacle to learners achieving mastery of the subject.[19-21]

Within postgraduate surgical training, there is an increasing use of animal models to replicate human anatomy.[22] Despite the majority of this being to teach surgical skills, there are examples within the literature where such models have been used to enhance anatomy teaching.[23] Animal models have the advantage of being more freely available than human cadaveric specimens, but they also overcome those worries that plastic models and computer-aided learning programs do not replicate reality.

The clinical specialties of cardiology, cardiothoracic surgery, anesthetics, and intensive care medicine all rely on a detailed knowledge of the cardiac basic sciences. The principle of having an integrated working knowledge of anatomy and physiology and how these relate to diagnosis is especially evident with respect to the heart. It is also very much evident to the student that function clearly depends on structure. Thus, we chose this aspect of clinical anatomy to introduce this method of integration to our institution. Previous work has shown an example of a dedicated musculoskeletal integrated teaching program.[24] The aim of this study is to build on the literature to show an integrated teaching program aimed to improve clinical medical students the use of cardiac basic science using a porcine-based model.

MATERIALS AND METHODS

Curriculum Development

Guiding principles

The primary objective was to teach basic cardiac anatomy and physiology in a manner to allow students to clearly contextualize and transfer knowledge to clinical practice. We specifically aimed to show how the underlying principles of anatomy and physiology were used on a daily basis by a practicing consultant cardiac surgeon in decision-making, such as frameworks for forming and understanding differential diagnosis. We used methods previously described[24] to drive the course development using the areas of needs assessment, learning objectives, methods of teaching, and assessment.

Course Design

All students were provided with a porcine heart and a set of standard surgical dissection instruments and a selection of suture materials. A consultant cardiac surgeon led the dissection of a porcine heart using a visualizer (real-time overhead projector) following the flow of blood during a standard cardiac cycle and focusing on specific structures as they were met (i.e., right atrium, right ventricle, left atrium, left ventricle) (Fig. 1). Specific attention was then placed on coronary anatomy as a specific entity. Breakaway sessions looking at physiology and clinical presentations of disease were employed during the session at relevant time points. We also used relevant clinical investigation modalities to highlight areas of relevance, such as echocardiogram and electrocardiogram.

During the clinical presentations of disease aspects, students were asked to use the underlying principles learnt during the dissection sessions and asked to apply this to the case scenarios. These were "real life clinical scenarios." Students were asked to explain the decision-making processes of the clinicians with the supporting underlying basic sciences. They were also asked to explain how the presenting signs and symptoms of different diseases could be explained by underlying changes in anatomy and physiology.

Course Outline

Dissection and tissue handling was explained in terms of operating with the mindset of being a cardiothoracic surgeon. Handling of all tissues was with instruments. Incisions were made as per access intraoperatively. Closure was with sutures to practice instrument handling and basic surgical skills.

Briefly, the dissection sessions consisted of the following components:

Gross Anatomy and Landmarks. Identification on delegates of the major landmarks of surface anatomy, position of the heart, mediastinum, and major vessels. Clinically relates to stab injuries and auscultation of heart sounds.

Concept of the Cardiac Skeleton. Conceptualized the cardiac skeleton and its importance for the attachment of cardiac muscle and support for valves. Relates to embryology and development. Physiological correlation with contraction and variation between left and right