Heart sounds in motion

Authors: Ashley Meikle,[A] Amal Fayruz Adan,[B] Findlay Smith,[A] Marla Bragagnolo,[C] Neal Uren,[A] Cian Murphy[A,D] and Anitha Varghese[B]

Aims

Development of a unique multimedia undergraduate educational digital clinical cardiology diagnostic support application.

Methods

Dem Dx application (app) is a portable educational and clinical diagnostic support software tool for use by healthcare professionals (HCPs), predominantly medical students during their years of case-based learning. Cardiology forms an important chapter within the app and, as with the remainder of the core content, consists of a diagnostic decision tree written by specialists. A HCP enters the presenting complaint of the patient, such as chest pain, and then follows along the branches of the tree in a step-wise manner. Branches comprise a comprehensive list of differential diagnoses, ultimately leading to one final diagnosis. This end diagnosis is expanded upon for the HCP using additional text explaining factors such as aetiology and complications of the disease process considered most likely in each instance.

In order to improve the clinical utility and user experience (UX) of the text-based cardiology decision tree, we sought to develop unique multimedia functionality in assisting professionals with the identification of cardiac murmurs. We used a digital stethoscope (Eko Stethoscope, Eko Devices Inc) to record patient heart sounds prior to and/or immediately after cardiac imaging using magnetic resonance imaging (MRI; Siemens 1.5T scanner, Cardiovascular Magnetic Resonance Unit, Royal Brompton Hospital). Digital sounds and associated images were collected and collated between June and August 2017. Cardiac MRI was performed based on standard departmental clinical protocols, no additional views were acquired or required for potential cardiology chapter app content enhancement. Cardiac images obtained were reviewed in conjunction with the consultant-verified clinical report to select which sections optimally demonstrated predominantly valve morphology and function in an UX-friendly manner. Of note, cardiac MRI is noisy during data acquisition but images generated are silent. Different types of MRI sequence can produce varying anatomical and functional cardiac assessment. We elected to use cine images, which simulate the appearance of cardiac motion.

Using video editing software (Final Cut Pro X Version 10.3.2), patient-specific digital heart sounds were partnered to silent dynamic cardiac images. We synchronised the first heart sound to the closure of the mitral and tricuspid valves, and coupled the second heart sound to the closure of the aortic and pulmonary valves. A variety of normal and abnormal sounds and images were collected after informed consent. In particular, patients were advised that this project was being undertaken on behalf of a with-profit organisation called Dem Dx Limited and would receive no personal financial reimbursement. Regardless of usage by the company, results would remain freely available within the public domain in iBook format, to be published simultaneously with cardiology chapter app content enhancement.

Results

Unique digitally-enhanced cardiac imaging video content was successfully embedded within the Dem Dx cardiology chapter alongside previously available written content and conventional still images such as electrocardiograms. Testing of clinical utility above standard undergraduate medical student teaching and UX will be undertaken during the first quarter of 2018.

Conclusion

Mobile devices and apps are being increasingly used on a global scale by healthcare professionals as educational and clinical diagnostic support tools. We have developed unique digitally enhanced cardiac imaging video content for enhancement of Dem Dx app content in the education and subsequent diagnosis of cardiac disease. ■

Conflict of interest statement

AV = Senior editor Dem Dx; AFA = Marketing director Dem Dx.

Authors: [A]University of Edinburgh, Edinburgh, Scotland, UK; [B]Dem Dx, London, UK; [C]University of Padua, Padua, Italy; [D]University of Warwick, Warwick, UK