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Digital training platform for interpreting radiographic images of the chest

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ABSTRACT

Introduction: Time delays and errors exist which lead to delays in patient care and misdiagnosis. Reporting clinicians follow guidance to form their own search strategy. However, little research has tested these training guides. With the use of eye tracking technology and expert input we developed a digital training platform to be used in chest image interpretation learning.
Methods: Two sections of a digital training platform were planned and developed; A) a search strategy training tool to assist reporters during their interpretation of images, and B) an educational tool to communicate the search strategies of expert viewers to trainees by using eye tracking technology.
Results: A digital training platform for use in chest image interpretation was created based on evidence within the literature, expert input and two search strategies previously used in clinical practice. Images and diagrams, aiding translation of the platform content, were incorporated where possible. The platform is structured to allow the chest image interpretation process to be clear, concise and methodical.
Conclusion: A search strategy was incorporated within the tool to investigate its use, with the possibility that it could be recommended as an evidence based approach for use by reporting clinicians. Eye tracking, a checklist and voice recordings have been combined to form a multi-dimensional learning tool, which has never been used in chest image interpretation learning before. The training platform for use in chest image interpretation learning has been designed, created and digitised. Future work will establish the efficacy of the developed approaches.

Introduction

There have been various systems and devices tested for their effectiveness in the education of healthcare and medical staff.[1,2] A search strategy within image interpretation is a method employed to ensure that all aspects of the image have been checked for abnormal features.[3] Search strategies used by healthcare professionals in image interpretation are often based on a variety of guidelines and sources or otherwise 'self-taught'.[3–5] Checklists have also proven to be a valuable resource within the healthcare settings.[6,7]

Eye tracking has been used to help understand the process of image interpretation and secondly to assess and provide feedback/training on the interpretation process. The feedback based on eye tracking data from the participant (expert or novice) was shown to have an effect, with a significant improvement noted following the provision of feedback to participants ($p = 0.021$).[8] Litchfield et al. (2008)[9] reported an improvement in the performance of both undergraduate and postgraduate radiographers when shown a preview of eye movements before their interpretation compared to when they were instructed to 'free search' or preview the image for 20 s prior to their image interpretation. Use of eye tracking

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feedback resulted in a 16% increase in radiology residents' performance compared to showing the observer the image again with no eye tracking feedback highlighted.[10] True positive rate increased and false positive rate decreased, indicating a real improvement in performance.[10]

To date no studies have been found which investigate the effect of using a digital training package based on eye tracking technology during chest image interpretation learning. With the use of eye tracking technology and expert input we aim to establish and evaluate a digital training platform.

Methods

The evidence and literature above informed the choices made regarding content and design of the digital training platform. A platform was developed to include: A) a search strategy training tool to assist reporters during their interpretation of images, and B) an educational tool to communicate the search strategies to trainees using eye tracking technology.

A). Search strategy training tool

Formation of the search strategy training tool

Members of the research team collaborated to develop a robust search strategy, which is suitable for use in chest image interpretation. The research team combined two approaches to chest image interpretation and with the addition of further content and scrutiny a comprehensive search strategy was developed and finalised following evaluation of the pilot packages.[11] (Personal communications Woznitza 2016)

Use of the search strategy training tool

The search strategy training tool is viewed simultaneously with a checklist when viewing a chest image during initial image interpretation training. It is envisaged that the user can with practice, overtime, avoid using the search strategy online. Instead they will simply follow the method of image interpretation they have developed and adapted consequent to using the tool.

Layout of the search strategy training tool

The search strategy comprises of a series of questions and prompts to guide the user to exclude pathologies, systematically search the image and form a diagnosis. The search strategy begins by allowing reporting clinicians to focus on the 'general considerations' of the image presentation. By encouraging participants to firstly technically evaluate the chest image projection and additional image details (i.e. anatomical markers, post processing labels) they have been presented with, the image interpretation process and expectations of the image presentation may be influenced. For example when presented with an antero posterior image rather than a postero anterior image of a chest the reporting clinician's interpretation of the patient's heart size may be influenced.

The search strategy comprises six sections which focus on different anatomy, pathologies and artefacts which may be present within the image;

(1) General image considerations
(2) Tubes/lines/devices
(3) Bony thorax, soft tissues
(4) Diaphragm/heart/mediastinum
(5) Lung zones
(6) Lung shadows

Five University academics who are qualified experienced radiographers reviewed the search strategy training tool and were asked to comment and provide iterative feedback. After considering all feedback, amendments were made to the search strategy training tool.

Following the completion of each section of the search strategy training tool, users are asked to give a preliminary diagnosis. These thoughts are combined at the end of the search strategy tool to enable viewers to combine ideas to generate a complete diagnosis i.e. an iterative process occurs to enable rapid and final differential diagnosis to be created for assessment and feedback.

B). Educational programme

Layout of the educational programme

The educational tool consists of videos comprising expert eye gazes and scan paths recorded during chest image interpretation and collected whilst the expert used the search strategy training tool. Expert input was from qualified reporting clinicians who specialise in chest image interpretation. The expert's eye gaze behaviours were recorded as well as verbalisation of their thought processes during their interpretation which provides a clear description of their search strategy. The training tool, once finalised, was transformed into an online digital format for participant's ease of use.

Eye tracking data such as scan paths were displayed over the image content. Fixations, where the participant concentrated on a specific area of the image, were demonstrated as coloured circles on the image with the area of the circle increasing as more time was spent fixating on an area. The fixations were commonly connected with saccades or a line joining the two areas of fixations. A saccade represents a quick movement of both eyes between areas of fixations. By observing such eye gaze behaviour, trainees can see where an expert fixates on the image and the areas experts gave greater visual and cognitive attention to. Essentially, this provides insight into how experts interpret images and the search strategy they implement.[12]

Expert eye tracking data collection

The eye tracking data collection was completed during the interpretation of 20 chest images by reporting clinicians to include a consultant radiologist and a consultant reporting radiographer trained to interpret chest images. The reporting clinicians were asked to interpret the images and provide the voice recordings for the development of the educational programme. We selected two clinicians to allow the incorporation of both disciplines (i.e radiographers and radiologists).

The Tobii Studio X60 eye tracker and the Tobii studio software© were utilised for data collection and for computing eye gaze metrics.[13] The remote non-intrusive eye tracker collected the data without interference to the participant's interpretation. The eye tracker was positioned inferior to the high resolution (1440px x 900px) 24″ LCD monitor that displayed the images, and angled upwards (30° cranially) to align with the participant's gaze.

We asked both expert reporting clinicians to speak aloud during the image interpretation session, both to verbalise the search strategy and help translate the search strategy to users watching the eye tracking videos. Voice recordings of the expert were also presented with the eye tracking data. They coincide with the eye tracking data and allow the expert to explain how he is systematically searching the image and why he is looking at specific areas of the image.[14]

Images

Images were presented on the eye tracking software using the Tagged Image File Format (TIFF). Images could not be presented in