Development and Piloting of an Augmented Reality ECG mobile app to support Paramedic Education

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BACKGROUND

During 2022 over 53,000 emergency calls for chest pain were made to the Scottish Ambulance Service (SAS, 2023). One differential of chest pain is Acute Coronary Syndrome (ACS) whereby fissuring of atheromatous plaque causes a narrowing or occlusion of the coronary arteries leading to myocardial injury or death. It is a leading cause of mortality and morbidity worldwide. Paramedics seek specific electrocardiograph (ECG) changes to support ACS diagnosis, specifically ST-segment elevation; this triggers the ACS pathway and emergency conveyance to definitive care (Primary Percutaneous Coronary Intervention). However, the cardiac electrophysiology of an ECG is an intangible and complex system with clinical indicators commonly deemed difficult to comprehend (Breen, Bond, & Finlay, 2019). Interpretation remains an ongoing challenge for new and experienced paramedics and novel ways to support interpretation are needed. Utilisation of supplemental learning techniques within healthcare fields has risen in recent years due to advancements in extended reality technologies including augmented reality (AR) (Parsons & MacCallum, 2021).

AIM

To develop an interactive AR mobile application visualising a 3D anatomical heart alongside varying clinical ECG presentations to enhance user knowledge of cardiac electrophysiology in paramedics.

Figure 1. Application logo/reference image & experimental testing set-up at SAS facility.

METHODS

Development

To ensure anatomical accuracy, the model of the heart was segmented from a sample DICOM dataset in 3D Slicer, then edited in 3DS Max and ZBrush, and lastly painted in Adobe Substance Painter. Functionality was developed in Unity 3D with imported assets and was scripted using Visual Studio Code. Scenes were designed to educate the user on coronary arteries, contiguous leads, and STEMI presentations. The AR scene allows the user to view and interact with the 3D heart model in real space through the device's camera.

Procedure

Participants completed a 10-question pre-test to assess initial knowledge. They were then allowed an unlimited time to explore the application. Once finished using the application, they were immediately given the post-test and a usability questionnaire to complete. The post-test was identical to the pre-test but reordered.

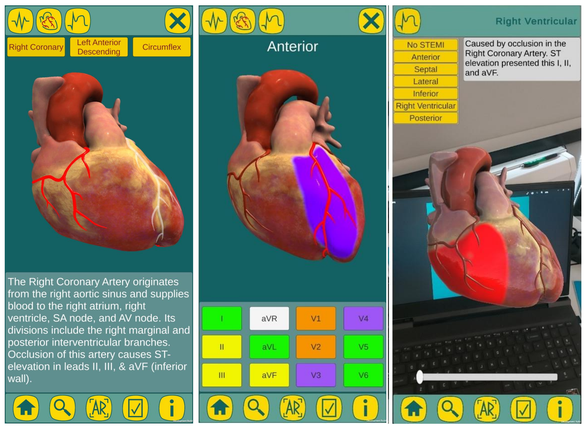

Figure 2. Application scenes on coronary arteries and STEMI presentation in AR.

Analysis

The usability and effectiveness of the application were tested on a cohort of 10 newly qualified paramedics (NQP's) in the SAS, using the System Usability Scale (Brooke, 1996), and comparing initial and post intervention knowledge of ECG interpretation. A Wilcoxon signed-rank test was used to compare pre and post-test scores.

RESULTS

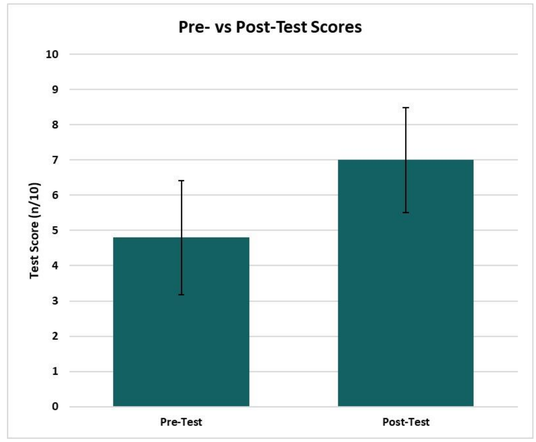

Figure 3. Pre and post-test scores presented as mean ± standard deviation (Pre: 4.8 ± 1.62; Post: 7.0 ± 1.49). Wilcoxon signed-rank resulted in $p = 0.024$.

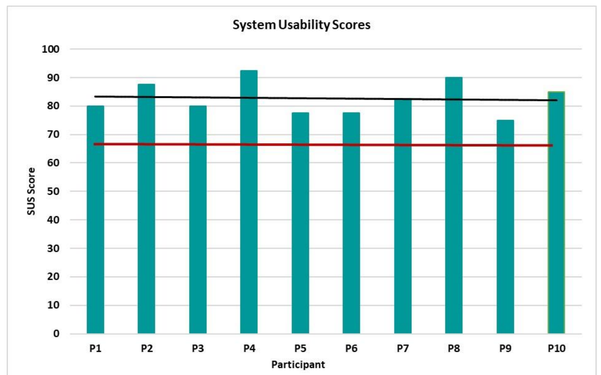

Figure 4. SUS scores per participant. Red line = standardised reference score (68.0), black line = mean score of application (82.8).

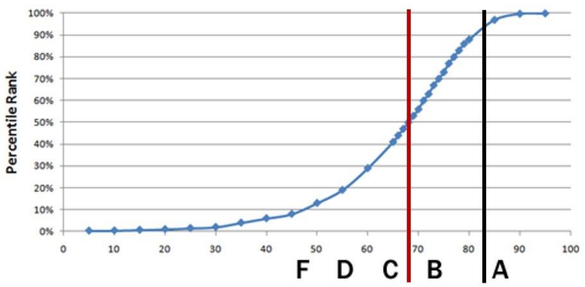

Figure 5. SUS score percentile ranks as letter grades. Red line = standardised reference score (68.0), black line = mean score of application (82.8).

SUMMARY of RESULTS

- Knowledge increased an average of 22% from pre (4.8 ± 1.62) to post-test (7.0 ± 1.49).
- The application received an average usability score of 82.8, 24.8 points higher than the SUS standardised reference benchmark of 68.
- The application receives an 'A' letter grade and 'excellent' adjective result placing it in the top 10% of scores (Sauro, 2011).

REFERENCES

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CONCLUSION

Improving interpretation of ECG within the context of pathophysiology of ACS may improve paramedics' understanding and diagnostic accuracy of ST elevation and therefore impact positively on patient outcome. Our experimental findings suggest the current efficacy of the application in facilitating user knowledge and support recommendations for future research. Though, further testing is needed to confirm the current trends and validate the application in a medical context.

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