OpenSCAT: Development of an open and extensible digital sports concussion assessment tool to support IoT-based athlete monitoring

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Abstract— **Athletes that participate in contact sport are at risk of suffering Sports-Related Concussion (SRC). A traditional approach of SRC testing relies on the 5th version of the pen-and-paper based sports concussion assessment tool (SCAT5). An open, digital equivalent may facilitate more efficient and transparent assessment. We describe a co-created developed iOS SCAT5 app to enable an Internet of Things (IoT) assessment.**

*Clinical Relevance—***iOS app to digitize SRC assessment to enhance efficiency, scalability, and convenience of assessment.**

I. INTRODUCTION

Sports-related concussion (SRC) encompasses cognitive, and symptom deficits. Premature return to play before full recovery can increase risk of injury. The SCAT5 is routinely used to monitor deficits but relies on subjective self-reported measures to inform diagnosis and is recorded with pen and paper. The non-digital approach limit's reliability and opportunities for integrated healthcare assessment. Here, we describe development of an efficient and secure smartphone application (app) on the format of the SCAT5.

II. METHODOLOGY

The SCAT5 guides SRC diagnosis and assessment by conducting these tests: (i) red flag identification; (ii) demographics; (iii) symptom evaluation; (iv) cognitive screen; (v) concentration; (vi) neurological and balance screen; (vii) delayed recall and (viii) review (decision and results).

A. Co-creation

A unified model of co-creation [1] was adopted to understand knowledge of: (1) characteristics of user needs, (2) user learning during assessments, (3) links between characteristics of existing user needs and (4) existing and co-created value. A team of clinicians, healthcare researchers, app developers and engineers completed this process

C. Primary user requirements

The goal is for the content to be intuitive, concise, and clean. It was important for the app to be functionally like the paper based SCAT5 and developed using a native user interface (UI).

III. SYSTEM ARCHITECTURE

An iPhone application was created in *XCode* using *SwiftUI* to ensure native UI coherence. *SwiftUI* is a toolkit for iOS app

design that provides the ability to build state-driven user interfaces [2]. The app is designed as a modular survey tool, which splits out the SCAT form into multiple, flexible UI components. This allows the survey to follow the same testing format of paper-based SCAT5, making the app more intuitive. Resulting data are pushed to an Application Programming Interface (API) that provides an interface for external devices to gain access to the SCAT data in an open format. JavaScript Object Notation *(JSON)* was chosen as the open format as it is one of the most common data formats for API requests [3].

IV. RESULTS

Iterative co-creation processes with healthcare professionals enabled development and implementation of nuanced features to improve the traditional SCAT5 approach. Such features are deemed appropriate and suitable for implementation, Fig 1.
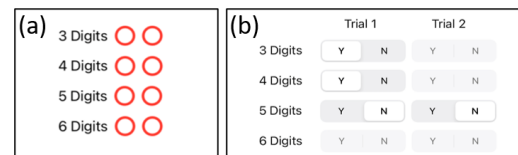

Figure 1: (a) initial check box option for digital recall, (b) co-creation created a more intuitive method with iOS functionality.

V. DISCUSSION AND CONCLUSION

The app was initially created with a close resemblance to the pen and paper SCAT5 but co-creation processes revealed limitations, features didn't adequately translate to a digital representation. Co-creation led to the suggestion of additional features for digital implementation including but not limited to the addition of extra words for recall which can be randomized to avoid learner effect as well as subtle app features to better track number recall. Data stored in the Open SCAT API is modular, where data from each component is stored separately in the database allowing subsets of data to be returned. This can enable development of extensible app's that use only subsets of SRC assessment data. An open, free and digital IoT enabled SCAT5 app can facilitate reliable SRC monitoring to enhance current clinical practice and/or integration with other digital health assessments.

REFERENCES

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