App Store for EHRs and Patients Both

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Abstract
The Substitutable Medical Applications, Reusable Technologies (SMART) Platforms project (www.smartplatforms.org) seeks to develop an iPhone-like health information technology platform with substitutable apps constructed around core services. It is funded by a grant from the Office of the National Coordinator of Health Information Technology's Strategic Health IT Advanced Research Projects (SHARP) Program. SMART technologies enable existing electronic health records and HIT platforms to run substitutable apps. Substitutability is the capability inherent in a system of replacing one application with another of similar functionality. We created a patient-facing SMART instance using the open source Indivo personally controlled health record (PCHR).

The SMART "read-only" API has been deployed on multiple systems, including the Cerner installation at Boston Children's Hospital and the World Vista EHR. We sought to SMART-enable Indivo, the open source reference PCHR upon which HealthVault and other PCHRs were modeled. PCHRs provide patients with a secure repository of their health information that can be exposed to apps across a programming interface. We updated the open source Indivo PCHR to support the SMART API, enabling Indivo to act as a patient-facing apps platform, running the same or similar versions of apps that face clinicians.

Methods
The Indivo (www.indivohealth.org) PCHR API provides rich sharing and write capabilities, complementing SMART's read only API calls, to support patient-facing apps. SMART-enabling Indivo allows it to become a platform that can run apps created for patients or doctors as well as hybrid apps that take advantage of the sharing and writing features of Indivo. Indivo and SMART both define a RESTful API for interacting with resources on the system, which provides a common ground. In order to support the SMART API within Indivo, Indivo's underlying data models were reconciled with those of the SMART project, ensuring that we would be able to encompass all of the necessary data. In addition, the existing Indivo API was audited for compatibility, and then integrated into a new SMART-enabled Indivo API. Since SMART uses the Resource Description Framework (RDF) web standard to represent data returned from its API, mechanisms were put in place for serializing our models to the SMART RDF/ XML format. Once the updated models, API, and serializations were in place, Indivo's user interface was extended to support the necessary SMART authentication schemes.

Results
Since its 2.0 release, Indivo can run SMART Applications that wish to take advantage of Indivo specific features, such as sharing. These apps can be built with a hybrid approach, degrading to base functionality when placed in a standard SMART container with read only capabilities and no sharing functionality. "SMART-enabled Indivo" is being deployed in multiple settings--academic and commercial, including in a 60 children's hospital research network comprising data on more than half of children with rheumatologic conditions, and a major genomic medicine initiative at Boston Children's Hospital.

Discussion
We have established a paradigm for a patient-facing apps platform that can run apps created for patients or doctors both. SMART-enabled Indivo also provides a powerful integration point between EHRs and PCHRs by leveraging the common data models defined by SMART, allowing for the flow of data between systems with minimal friction. This connection between the EHR and PCHR will be explored as we build out a connector SMART app that allows users to populate their Indivo account from other SMART containers. In addition, this common data language is an important step in providing patients with access to their medical record data, and combined with Indivo's write capabilities, a pathway to integrating patient reported outcomes in clinical trials and clinical care.