



PRISMS: An mHealth research study ecosystem for studying asthma patient population.

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UCLA's Mobilize Labs Teams up with UCLA's MII and CS Departments

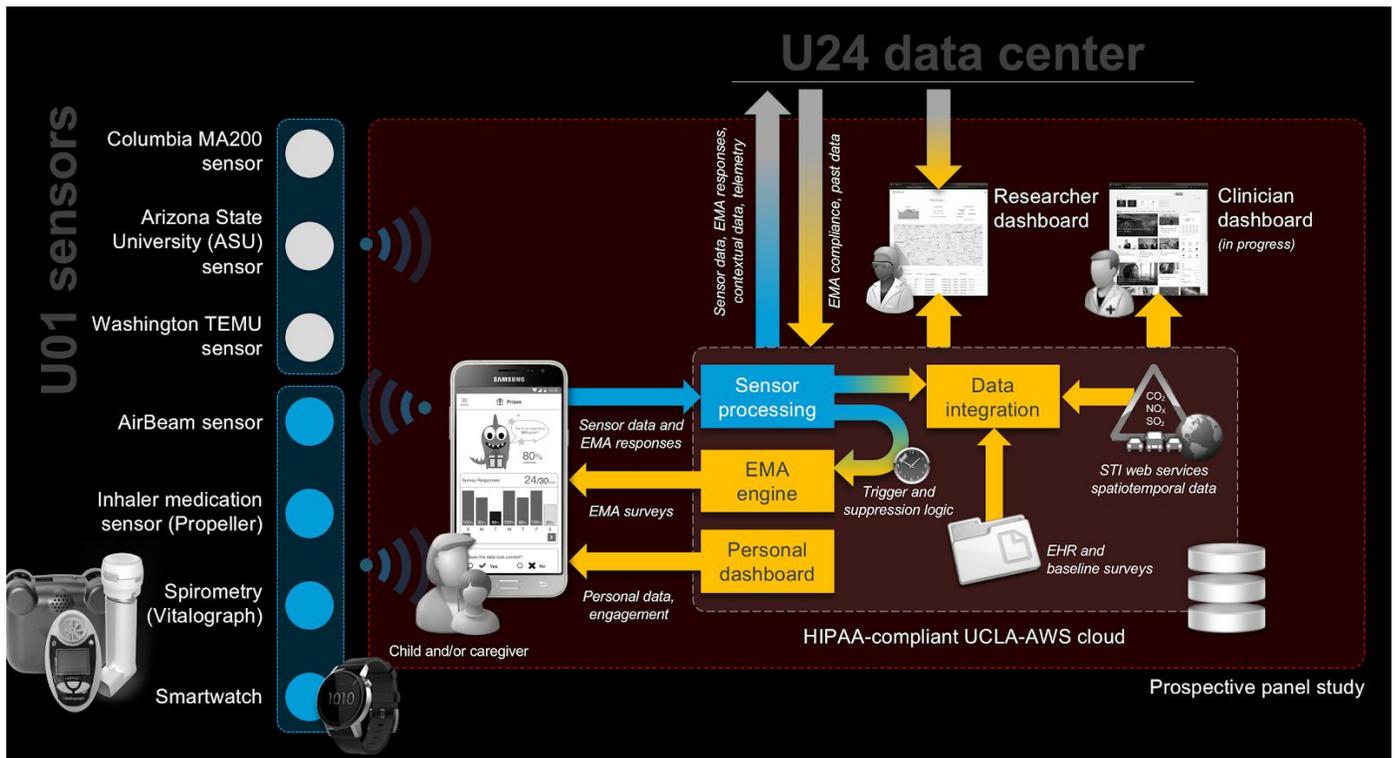
The Mobilize Labs team within the Office of Information Technology at UCLA has been fortunate enough to team up with Researchers from UCLA's Medical Imaging Informatics and CS departments on the PRISMS NIH Grant as part of the NIBIB Program. We are in the fourth year of this very cutting edge sensor and mhealth analytics study and are in the middle of our final panel study deployment. The project is a mobile data collection featuring EMAs (Ecological Momentary Assessment), which is a specialty area of the ML team. The project has been key in the ML team's development of advanced native app and sensor

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platform integrations, triggers and analytics expertise. The ML's team's efforts have spanned the four year project, and have been funded by more than 1 Million in grant funding.

An integrated mHealth research study ecosystem

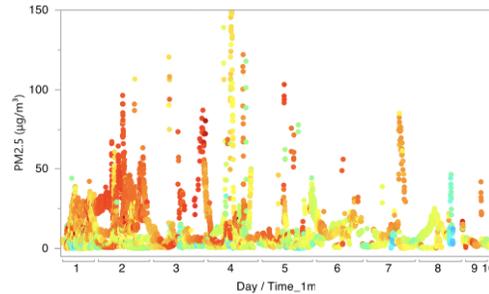
The Los Angeles Pediatric Research using Integrated Sensor Monitoring Systems (LA PRISMS) Center is fostering the development and application of mobile health (mHealth) technologies that deepen our scientific understanding and clinical management of pediatric conditions. Bringing together leading experts from UCLA and USC in biomedical informatics, computer science, wireless health, environmental science and health, and pediatrics, this Center focuses on the creation of innovative end-to-end software infrastructure for pediatric sensor-based health monitoring.



Collecting real time sensor & survey data

The ML PRISMS team effort included working hard to standardize PRISMS study design, deployments and execution. Significant effort included defining APIs enabling data exchange from sensors to a mobile device; and from the mobile device to cloud are explored, leveraging existing mHealth and communication protocols. Key aspects of this software infrastructure include securing all aspects of the data collection and transmission process, and algorithms for optimizing power usage on sensors and the mobile device.

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The ML Prisms team also helped develop the informatics infrastructure to enable context around sensed data, to analyze the data, and to optimize the range of interactions and activities different users will have with BREATHE (The Biomedical REAL-Time Health Evaluation) platform. It focuses on combining data acquired from the U24 data center with contextual information (e.g., regional air quality, clinical elements from the patient's electronic health record, etc.) with real-time processing and analysis infrastructure. Key developments include creating a unified data model for the information; and interfaces for cohort discovery, protocol definition, monitoring/updating of active data collection experiments.

ML Designs, Delivers and Delights with Personalized Gamified Participation

The PRISMS participant population is a special population of pediatric participants. The Mobilize Labs team worked hard to create an interface that would engage this particular group. A concept was developed to encourage and gamify their participation “compliance” that is part Tamagotchi character, part Pokemon entertainment. The character eats surveys for food, and is sad when it doesn't get fed. Each dragon pet hatches from an egg, during the App Setup process, and then the user gets to select a name for it for example 'Bob'. When the user is notified of an available survey, they are told that their pet dragon “Bob” is hungry. This is the “pull mechanism” to bring the participants back into the app.



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A critical part of a research study is data collection or 'compliance'. Did the participant actually fill out the surveys? Did they respond to the notifications that were sent? This is especially challenging in child populations that have low attention spans and require constant feedback to stay on task. The mobile app was also extensively instrumented to monitor and send compliance and app performance telemetry without sending any personally identifiable information (PII).

Real-time querying of participants with sensor-triggered surveys

One of the most powerful aspects of the PRISMS mHealth platform is the ability to query subjects in the field at critical moments such as right after they have had an asthma attack, termed ecological momentary assessment (EMA). This innovative design leverages the use of mobile phones to capture research data in the field, in real time. An important scientific benefit of this approach is that it dramatically reduces the time between important clinical events and when they are reported to researchers. Current patient survey methods involve asking patients to remember events and experiences that occurred weeks or even months ago. In contrast, in the PRISMS system we are able to capture patient responses within minutes or hours of key clinical events. Importantly, all survey data can be analyzed within the context of a rich set of streaming sensor data from heart rate to air quality via wearable (heart rate monitoring watch) and carried sensors (air quality monitors attached to the child's backpack) recording and reporting to the app via bluetooth.

Research data visualization so you "know as you go"

One of the biggest challenges and inefficiencies in any research study is poor data quality. To combat this, we created a real-time research data monitoring system that allowed researchers to immediately notice if any data pipelines were not working properly so they could be rapidly fixed and ensure minimal data loss. The amount of potential streamed data could overwhelm a system, but this system was designed to deal with a large number of simultaneous data streams sending data 24/7 (Apache Kafka) into a relational database (Postgresql).



Panel Study 2019

nate_researcher
logout

Data Flow Checks (24 hrs)

● Surveys ● Inhaler ● Airbeam ● Heart Rate ● Spirometer

Participants

ID	Started On	Study Progress	Data Flow Checks (24 hrs)	Survey Compliance
prisms.209	Tue Apr 30 2019	<div style="width: 100%;"></div>	○ Surveys ● Inhaler ● Airbeam ● Heart Rate ● Spirometer	no survey data
prisms.208	Thu Apr 25 2019	<div style="width: 80%;"></div>	● Surveys ○ Inhaler ● Airbeam ● Heart Rate ● Spirometer	36% 14 / 39
prisms.207	Wed Apr 17 2019	<div style="width: 90%;"></div>	○ Surveys ● Inhaler ● Airbeam ● Heart Rate ○ Spirometer	42% 36 / 85
prisms.206	Mon Apr 15 2019	<div style="width: 60%;"></div>	○ Surveys ○ Inhaler ○ Airbeam ○ Heart Rate ○ Spirometer	50% 3 / 6
prisms.205	Thu Apr 11 2019	<div style="width: 70%;"></div>	○ Surveys ○ Inhaler ○ Airbeam ○ Heart Rate ○ Spirometer	18% 9 / 49
prisms.204	Mon Mar 25 2019	<div style="width: 85%;"></div>	○ Surveys ○ Inhaler ○ Airbeam ○ Heart Rate ○ Spirometer	33% 3 / 9
prisms.203	Mon Mar 25 2019	<div style="width: 95%;"></div>	○ Surveys ○ Inhaler ○ Airbeam ○ Heart Rate ○ Spirometer	57% 4 / 7
prisms.202	Thu Mar 21 2019	<div style="width: 98%;"></div>	○ Surveys ○ Inhaler ○ Airbeam ○ Heart Rate ○ Spirometer	87% 61 / 70
prisms.200	Mon Mar 11 2019	<div style="width: 99%;"></div>	○ Surveys ○ Inhaler ○ Airbeam ○ Heart Rate ○ Spirometer	86% 30 / 35
prisms.198	Mon Mar 04 2019	<div style="width: 95%;"></div>	○ Surveys ○ Inhaler ○ Airbeam ○ Heart Rate ○ Spirometer	52% 37 / 71

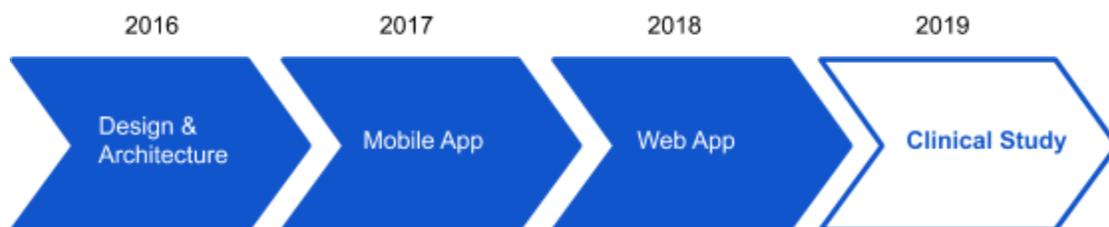
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2019 Clinical study currently ongoing

Our collaborators at the USC Keck School of Medicine were responsible for deploying the technology in the field as part of a clinical study on a child asthma population in Los Angeles. They developed testing protocols to assess the field performance of sensors employed as part of BREATHE in key microenvironments and the utility of highly resolved spatial and temporal data to inform such insights. A framework for evaluating system performance and real-world testing of the platform for self-management and early interventions is developed. The use of ecological momentary assessment (EMA) methods to understand the environment is employed. Working with Project 3, for each individual subject, tailored predictive models that employ real-time contextual data will be developed and tested for asthma risk assessment.

Outcomes: 1) clinical study (ongoing) and 2) sophisticated mHealth platform

The PRISMS initiative is split into three collaborative teams that have worked together to design, build, and deploy the mHealth platform in the 2019 clinical study. Team 1 integrated Sensing from the Device to the Cloud. Team 2 Integrating & Visualizing Clinical, Environmental, and Sensor Data. Team 3 Real-time Asthma and Air Pollution Project (Asthma APP). The timeline of our progress towards deploying the mHealth platform in the field for the 2019 clinical study is summarized below.



We are currently writing up several publications for the PRISMS project, and are actively pursuing additional academic and commercial outputs that could spin off of the successful PRISMS Initiative.



Additional resources

PRISMS Project Website:

<https://www.mii.ucla.edu/research/projects/prisms>

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