HARVARD MEDICAL SCHOOL

cbmi Center for Biomedical Informatics

dbip

Boston Children's Hospital

The Meeting at Harvard on a

Health Information Technology Platform

"ITdotHealth II" — September 10–11, 2012

Executive Summaries

Sponsors

The Office of the National Coordinator for Health Information Technology

SIEMENS

Table of Contents

Key Themes from ITdotHealth II

Speaker: **Kenneth Mandl**, *Director, Intelligent Health Lab, Boston Children's Hospital Informatics Program; Associate Professor, Harvard Medical School*

Overview

Substitutable apps that run across diverse HIT platforms are feasible, as the experience of the first two years of the SMART Platforms project has shown. Several platforms have become SMART-enabled and several SMART apps that run across HIT platforms have been developed and are now in use. The challenge at this time is to scale this concept and broaden adoption. This will create a market and will unleash the creativity of innovative app developers. One key step is building an easy-to-use API, which has been done. Improvements are underway to add write capabilities. Another important step is to explore forming a SMART consortium which would maintain the SMART API standard, which will underpin an app store (or stores) for health.

Context

On September 10 and 11, many of the leading thinkers in the world of health information technology came together to review the role and importance of substitutable apps, to discuss a standard that will underpin an "app store" for health, and to determine what actions are required to create an ecosystem for such apps. A few of the key themes are summarized below, and summaries of each session follow.

Key Themes

- **At this time, EHR vendors have great power and momentum.**

  As Professor Clayton Christensen explained, early in the development of any new technology, the winners are the companies that have a proprietary, interdependent architecture. His theory is confirmed by the positions of large vendors such as Epic, Cerner, and Siemens. In the words of one participant, "Do not bet against the momentum of the EHR vendors."

  Several participants acknowledged that at this time, the EHRs that exist don't provide rich functionality and that EHR vendors generally lack the capability and/or interest to rapidly develop or innovate clinical applications. It is just not a priority for these vendors. Their resources are focused on complying with meaningful use, responding to the requests of their customers, and on sales.

  As a result, there are neglected specialties (like pediatrics and oncology) where existing EHRs don't provide rich functionality. Most providers lack the resources to design solutions for these niche use cases. Also, sharing data from EHRs across organizations or with other caregivers (such as pharma-cists) is difficult or nonexistent.

- **The SMART project envisions complementing existing EHRs with SMART containers and apps.**

  While proprietary EHRs are well positioned today, as these products improve and eventually become "good enough," a modular architecture is likely to become preferred.

  There are already many problems for which modular applications can provide an elegant solution. Among the examples shared were the BP Centile app and the Diabetes Monograph. These relatively simple-to-create apps with compelling user interfaces can easily be integrated with a provider's existing EHR and can provide clinicians important data in real time.

  The simplicity and success of the BP Centiles app, where a prototype that has been enthusiastically embraced by clinicians was created in less than three months, shows what is possible.

  Several other apps were described that have been or are being developed. These presentations showed that substitutable apps are feasible and this concept is on its way to becoming a reality. The key challenge is increasing the concept's scale and adoption. Important steps to increasing adoption include:

  — *Adopting the SMART API.* The SMART API is the language through which SMART apps talk to SMART-enabled containers. The current API is read only, but adding the ability to write is on the roadmap. An important goal is making the SMART API extremely easy to use for developers. One participant posited that perhaps 150 core functions are required to make an API robust enough.

  — *Attracting innovative developers.* Just having an API is not enough, as there will be many APIs. The key to success is having a wealth of exciting, user-friendly applications that solve real-world problems, like the BP Centiles app. Application developers will be attracted when there is a market with critical mass and a community, and when their products can be used broadly. Polyglot, which won the SMART app challenge, is an example of a small company with a compelling app that had difficulty getting this app integrated with EHRs. The SMART API provides a solution.

— *Having SMART-enabled platforms.* In just the past few years, considerable progress has been made in SMART-enabling several platforms, such as Indivo and i2b2. Containers such as Mirth are SMART-enabled and vSMART provides a way for providers to connect to apps without having to change their EHR. Making these platforms SMART-enabled has been relatively easy and enables the platforms to run current and future SMART apps.

Concern was expressed that as more apps are developed, different user interfaces could be confusing for users and could even raise liability issues. Also, data security and privacy are major issues.

- **There is much interest in the idea of a SMART consortium.**

Dr. Mandl presented a strawman for a possible SMART consortium. This consortium would maintain the standard for the SMART API, would provide continued performance testing, and would interface with ONC and relevant federal standards bodies. It also would maintain and enforce a SMART trademark, host a public website with documentation, convene an annual meeting for members, and provide quarterly updates. This consortium might follow a model of a successful group like W3C.

Membership could include EHR vendors and HIT software companies, HIE organizations, payers, health systems, data integration companies, and pharma and telecom companies. Government agencies such as the NIH, FDA, and CDC might participate, and individuals could also join.

Benefits of membership would include voting rights on API standards and early looks at API releases. Members would also receive information from a members-only website and mailings. Revenue might be generated through tiered dues, grants, sponsorship, and donations.

This consortium is not envisioned as a classic standards organization, a certification organization, or the owner or operator of an app store.

SMART in general, and this consortium in particular, would not change the transactional workflows in EHRs. But SMART would enable the creation of apps for specific purposes. This would be a nimbleness that doesn't exist today among the EHR vendors.

Participants expressed general interest in the idea of a consortium, and raised the following points:

— *Geographic reach.* Consideration should be given to making the consortium international.

— *Timing.* Some time is required (at least six months) to lay the foundation for the consortium.

— *Launch strategy.* Perhaps the consortium can begin and be nurtured within an existing organization instead of creating a brand new organization.

Dr. Mandl promised to take these comments into account, but he heard enough enthusiasm throughout this meeting to explore advancing the consortium to the next stage.

Making EHR Apps Substitutable: Theory & Experience

- Speaker: **Joshua Mandel**, *Lead Architect, SMART Platforms; Research Faculty, Boston Children's Hospital Informatics Program; Instructor, Harvard Medical School*

Overview

Substitutable apps will give organizations choices, enabling them to mix and match apps. To give app developers the tools to create substitutable apps that can plug into diverse IT systems, the following functionality is required: UI, data, an API, and authentication.

In a short period of time, SMART has made important technical choices for each area of functionality, particularly data. Progress also has been shown through the creation of several simple, innovative apps that show what is possible. SMART aims to continue this progress over the next year through an aggressive roadmap.

Context

Joshua Mandel described what SMART is, the progress that has been made, the lessons that have been learned, and the future roadmap.

Key Takeaways

- **The goal of SMART is to give app developers tools to build substitutable apps.**

  The problem that SMART is focused on solving is giving app developers the tools they need to build apps that are substitutable and that can plug into a diverse set of IT systems. Four types of functionality are needed for substitutable apps to work:

  — *UI.* There has to be some place for an app to live; it could be tightly embedded in an existing system or pop out in a new window.

  — *Data.* Apps need access to contextual data about the users and patients and need access to medical data, such as medical problems, allergies, lab results, etc. An app must be able to access data in a predictable way.

  — *API.* Apps need a programming interface through which to request data.

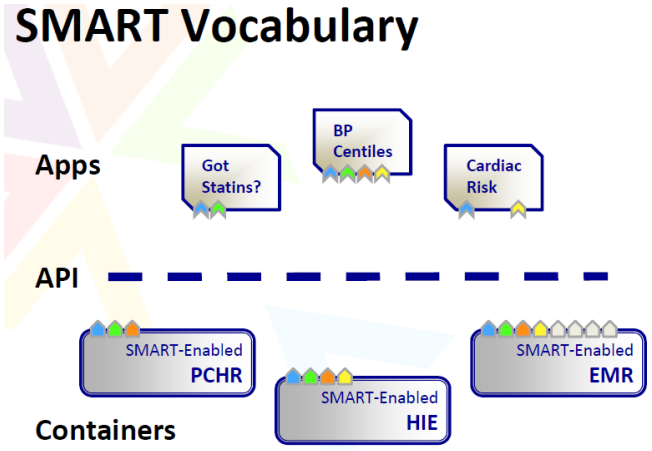
  — *Authentication.* All of these activities have to happen in an authenticated way so that only authorized apps can run on the platform.

  Understanding how SMART works requires familiarity with a few definitions. Key definitions are:

  — *Apps.* An app is an individual unit of functionality. A SMART app can run on top of any SMART system.

  — *Containers.* A container holds data. Containers can be "SMART-enabled," which makes them capable of running SMART apps. This includes a SMART-enabled PCHR, a SMART-enabled EMR, and SMART-enabled HIE.

  — *API.* An API is the language through which apps talk to the platform. The SMART API is the language through which SMART apps talk to SMART-enabled containers.



  — *Substitutability*. This is the ability to mix and match apps. Old ones can be swapped out and new ones switched in. Substitutability provides choice. For app developers, substitutability means reuse. You can build an app once and run it on top of multiple containers without having to know all of the underlying details and differences among platforms.

> *"Substitutability gives you choice about functionality."*
> — Joshua Mandel

- **Building the SMART platform has involved making several important technical choices.**

  Among the important technical choices made by the SMART team are:

  — *UI.* SMART uses the web for UI integration. The UI is put into a frame and the frame points to an app. From an app developer's perspective, the details don't matter; they are just writing a web app. It is the responsibility of the container to figure out where it needs to be.

  — *Data.* An app needs contextual data and data about a particular patient. The hard part is representing the medical record in a way that is consistent across all systems. SMART's technical choices were inspired by

the PCAST Report on Health IT which said, "The best way to manage and store data for advanced data-analytical techniques is to break data down into the smallest individual pieces that make sense to exchange or aggregate." This report indicates that apps should be focused on "little facts."

In addition to focusing on breaking medical data into little facts, SMART also leverages standard terminology, like SNOWMED CT and RxNorm and LOINC, to represent those individual facts.

This idea of focusing on data was based on the recognition that most of the standards available for health data were about interoperability. Health IT standards have not been open or free, unambiguous or expressive, or easy to learn. They have not been developer friendly. Since the SMART project began in 2010 the standards have gotten better. SMART is taking a hard look to leverage the standards further.

> *"Health IT standards are about pushing out a document with a clinical summary from one site to another, and not so much about giving app developers the tools that they really want to interact with those data."*
> — Joshua Mandel

SMART was inspired by PHR models, such as Indivo, Microsoft HealthVault, and Google Health CCR Subset. These are all platforms that support apps and they have APIs with a goal of getting people to write apps on them. They also have a common set of data types and app developers can then request the data they want.

SMART has taken a very pragmatic approach to the data model, which has involved focusing first on common outpatient data. This has meant first modeling things like problems and medications and allergies. The belief is that this pragmatic 80/20 approach and use of standard terminologies will enable app developers to get started.

— *API.* The approach SMART takes is that every resource of the patient medical record gets a url.

— *Authentication.* The decision that has been made is that SMART is using an open web standard called OAuth to delegate access to applications.

- **There are already several examples of SMART apps, showing what is possible.**

Several SMART apps already exist. Those built by the SMART team are open source work and are available in a public demo at sandbox.SMARTplatforms.org.

— *Got Statins.* This app connects to the SMART client library, gets a medication list, and checks each one to determine if it is in a known list of statin drugs. It is a simple app with just 51 lines of html and java script.

> *"Writing a simple app should be a simple job. That's what SMART tries to do."*
> — Joshua Mandel

— *Cardiovascular risk score.* This app provides a patient's 10-year risk of heart attack and stroke, based on the patient's demographics and some pertinent lab values. This can be used as a counseling tool and provides "what-if" scenarios in real time such as how a patient's risk changes if they quit smoking and lower their blood pressure.

— *Pediatric blood pressures.* This app calculates percentiles for pediatric blood pressures based on contextual factors such as a child's age, height, and gender.

— *Diabetes monograph.* This provides a view at a glance of how a diabetic patient is doing. It combines information about a patient's problems, with medication information and lab results.

— *Polyglot.* This app was built as part of a SMART app challenge. It generates patient-facing medication instructions at a reading level that is appropriate for the patient, and it can be translated into over one dozen languages. So, a physician with a patient who speaks a different language can print a handout for the patient in that language. Also, the instructions can be printed in large fonts for patients with vision issues.

In addition to apps, Mirth is a data repository (a container) that fuels health information exchanges. This company has been working to implement the SMART API on top of its data repository. While working "inside" the Mirth product, a user would be able to easily access SMART apps that are hosted in the cloud.

- **SMART has an ambitious roadmap.**

To date SMART has had four releases, starting in August 2010. The newest release—SMART 0.5—has just been made available. The plan over the next year is to iterate the design every three months. The roadmap includes expanding the breadth and depth of the data models and adding several new features every quarter. Examples of possible features include adding interfaces for apps to filter the results they get back, looking at ways to generalize the app launch, and letting apps request finer grain payloads.

Apps & APIs Innovating With and Around Vendor and Homegrown EHRs

- Moderator: **Brian Athey**, *Chair, University of Michigan Medical School, Department of Computational Medicine and Bioinformatics; Professor, UM Medical School*
- Presenters: **Howard Goldberg**, *Senior Corporate Manager, Partners Health Care; Lecturer, Harvard Medical School*
  John Halamka, *Chief Information Officer, Beth Israel Deaconess Medical Center; Co-Chair, National Health IT Standards Committee; Professor, Harvard Medical School*
  John Hutton, *Director of Biomedical Informatics, Cincinnati Children's Hospital; Professor, University of Cincinnati College of Medicine*
  John Mattison, *Chief Medical Information Officer, Kaiser Permanente*

Overview

This panel made clear that they see value in having modular, substitutable applications in hospitals and health systems. However, they also made clear the enormous barriers that exist. EHR vendors are powerful and enabling modular apps are not currently a priority. Enabling their systems for modular apps also may not be a priority for hospitals, which have long lists of IT projects on which to work. And current EHRs may not have the proper data for subspecialties and research.

But despite these challenges, there are approaches that provide optimism. Meaningful use stages 2 and 3 will increase interoperability and the ability to read and write data in EHRs. There are ideas to advance the use of open source—and to engage commercial EHR vendors in this process. And, a modern technology infrastructure and clear data standards can create an ecosystem where innovation can flourish.

Context

The panelists shared their experience and perspectives on EHRs and modular apps. The described why modular apps are important and the institutional barriers that exist to creating systems that support apps.

Key Takeaways

- **The University of Michigan is taking both a top-down and a bottom-up approach.**

  The University of Michigan is a $3 billion health system; $2 billion is for patient care and $1 billion is academic work. The future is "translating things from more basic science . . . into the clinical arena." The organization is focused on becoming a learning health system, which requires both a top-down and a bottom-up approach.

  — *Top-down.* The top-down, command-and-control approach is necessary to provide the infrastructure and to incorporate elements for i2b2, SMART, and later tranSMART.

  — *Bottom-up.* This is where innovation will occur. The idea is to have 1,000 flowers (or perhaps one million) bloom, which requires changing the culture, empowering people, and incentivizing them.

> *"If we build a huge, top-down, heavyweight enterprise, it collapses. We need to build smaller, modular capabilities that can be linked together in a platform."*
> — Brian Athey

- **The need for a platform (like SMART) is great. Lack of such a platform results in numerous obstacles.**

  Howard Goldberg, who runs an informatics group within Partners, shared two vignettes and a cautionary tale that illustrate the need for a common platform.

  — *Vignette 1: Research inside the Partners ambulatory medical record.* Partners is friendly to and supportive of research. However, research that involves getting an app into Partners' Longitudinal Medical Record (LMR) can be a slow, multi-step process requiring approvals, securing grants, and prioritization.

> *"Anywhere you're trying to run an operational system, it is very difficult to insert novel applications into your EHR. You have operational constraints and the proprietary nature of the system or systems you may be dealing with."*
> — Howard Goldberg

  — *Vignette 2: Multi-site trials with different systems*. Multi-site trials that use different decision support systems and different EHRs can be slow and complex. Even with a web-based API and even when all sites use the same EHR, like Epic, the implementations and cultures are different enough so that each organization has to do its own user interface. If there were middle customization

so a site could just plug an app in, it would be much quicker to start and test new apps and interventions.

— *Cautionary tale: Consequences of IP restrictions*. Partners has decided to adopt Epic, which will be a three- to four-year process. Partners will contribute IP to the Epic community and will be able to take advantage of IP developed by other members of this community. But Partners, which has previously had a more open approach, won't be able to benefit from IP on other platforms. So, Partners has decided to adopt a system with a great deal of functionality but sacrifices the ability to do broader innovation and to access IP from outside the Epic community.

- **Stage 2 and 3 of the meaningful use standards will take the EHR to a different level.**

John Halamka described a few requirements of the stage 2 meaningful use standards. There are requirements:

— *For operationalizing the healthcare data exchange.* There must be an ability to exchange data across EHR vendors, meaning that a vendor can no longer have a walled garden.

— *For read-write capabilities.* Vendors must provide write-back capabilities.

— *That data be made available for patients.* Patients must not only have view access, but they must also be able to transmit. Patients are the stewards of their data.

Even though the stage 2 standards just came out, there is already work taking place on the stage 3 standards. In stage 3 there will be capacity for much more patient-generated data and significantly better structured data. There will also be the capacity to extend the EHR in new ways through structured data forms with questions and answers. These standards will create an ecosystem that will enable greater interoperability and innovation.

> *"Stage 3 is try to take the EHR to a different level."*
> — John Halamka

In addition to meaningful use as a federal policy, there are also important state policies. In Massachusetts, the vision is to create an ecosystem where all stakeholders—providers, patients, payers, and innovators—participate in the ecosystem, as long as they are part of the "trust fabric." Also, the five ACOs in Massachusetts must all open up their silos of data and share data with competitors.

Seeing the importance of being able to send and receive data, Beth Israel Deaconess in Boston is forming a new organization to be a data exchange entity. It wants to ensure that data can flow into apps from innovative third parties.

- **In healthcare, turning an idea like modular apps into reality is an enormous challenge.**

Per John Mattison, turning ideas into reality is onerous. This is particularly the case at Kaiser Permanente, where the scale is immense. Because of this scale, Kaiser's requirements for performance and interoperability are unique. Kaiser had thousands of systems that didn't talk to each other, making the need for interoperability critical. To get its systems to communicate internally, Kaiser embraced SNOMED and other standards. Other comments from Dr. Mattison about turning ideas into reality include:

— *Improvements come from operationalization.* Improving care doesn't come from purchasing and installing the out-of-the-box version of an EHR. Improvements come from how the EHR is configured and operationalized. Also, once an organization implements an EHR, it is very difficult (and potentially dangerous for patients) to switch.

— *This is the Stone Age of decision support.* There aren't yet any commercial decision support products that are well architected. And moving to an architecture designed around decision support is going to be very disruptive. It will require different workflows in different venues by different providers. Putting omics at the core of decision support and shared decision making is coming, and will also be incredible disruptive.

— *Open source has much potential.* Dr. Mattison is optimistic about the future role of open source, but is pessimistic it will take root without coopting commercial vendors in the process. Because they are so powerful, betting against existing EHR vendors doesn't seem like a good idea. Involving them is essential and can be done (as a Trojan horse model) because the future is around coordinated care and data liquidity. Open source can help drive that liquidity.

— *Modular components are needed.* Modular components can become a source of collaboration between the open source world and commercial vendors. Innovation can take place through open source, with support and distribution from existing vendors.

— *Start with a small, virtually integrated delivery network.* After articulating a clear vision of the end state and updating this vision through collaborative mechanisms, it may be best to start with a small, virtually integrated delivery network that doesn't have a lot of money.

> *"If the open source world is going to succeed, it is going to be driven to a great extent by cost savings."*
> — John Mattison

— *Separate inpatient and outpatient.* Separation is needed because the business and workflow paradigms are so

radically different. But there needs to be a coordination of the user interface.

— *Know which sources to use.* There needs to be a deliberate management of crowd sourcing, expert sourcing, and a hybrid, with knowledge of when to use each.

- **Subspecialty networks and researchers face unique challenges with systems and data.**

  John Hutton observed that the data needed by those in a subspecialty like pediatrics is not easy to get and is often not adequate. Children have different diseases than adults, and EHRs tend to be designed to capture information about adults. Children's hospitals are an example of a neglected group. And, attempting to aggregate data from the nation's children's hospitals is difficult as they use different systems and different semantics.

  > *"Building these networks is a nightmare in terms of being able to pull the data, make sense of it, and aggregate it."*
  > — John Hutton

  The vanilla versions of EHRs are not really adequate for subspecialties and require a great deal of customization. But when customization occurs, significant IP issues can arise when one provider attempts to share IP with another. With EHR vendors, the sense of public good may or may not be there and legal skirmishes may arise. This can also affect the ability to receive grants, where use of open source may be required.

  Conducting research also is an issue. Hospitals are busy maintaining their systems to conduct their day-to-day business and operations. The nature of research is about trying novel things that are on the cutting edge. This can lead to institutional conflicts between the people who run the hospital and those engaged in research.

Discussion

- **Regulate data openness.** One participant suggested regulations that require vendors to have data openness. This could spur a great deal of innovation.
- **Pulling and receiving data.** A participant noted that it is currently hard to get data out of containers. Dr. Halamka said that part of the stage 3 meaningful use standards will be to enable a greater flow of data.
- **PHRs.** A participant suggested that as omics grows, PHRs will have to come back.
- **Current reality.** While the vision of what will be possible in the future is exciting, noted one participant, there is a huge gap between this vision and today's reality. An example was shared of trying to get a physician's office to fax a person their own medical information, only to be told (incorrectly) that this information couldn't be faxed due to HIPAA. So, a vision of EHRs that share data and support apps is great, but it is a long way from today's current reality.

Keynote: Data, Predictions, and Decisions: On Computational Futures for Evidence-Based Healthcare

- Speaker: **Eric Horvitz**, *Distinguished Scientist & Deputy Managing Director, Microsoft Research*

Overview

As the amount of data in healthcare grows, it can be used to create increasingly accurate predictive models. What is most exciting is that these predictions can affect decisions. Richer models can improve safety and reduce errors, decrease unnecessary readmissions, and help make policy decisions, such as whether to invest in an intervention, like a post-discharge program, for a group of patients. An idea is to create a general predictive platform where data and models are shared, and on top of which apps sit.

Context

Eric Horvitz discussed how predictive models can be translated into use by clinicians, which can change how medicine is practiced. He also articulated a vision for a general predictive platform.

Key Takeaways

- **New types of predictive models are leading to new decision models—and ultimately better decisions.**

  For years the algorithms were ahead of the data. But over the past 15 years, methods have been developed to walk through large amounts of data, and then predict the likelihood that the model explains the data.

  What is perhaps most exciting is going from predictions—which are becoming more commonplace—to real-time actions based on those predictions.

- **One use of predictive models is to predict hospital readmissions.**

  Hospital readmissions are a frequent and costly problem. Research shows that about 20% of all discharged Medicare patients are readmitted within 30 days and about 90% are readmitted within 90 days. As of 2004, the estimated cost to Medicare of these readmissions was $17.4 billion.

  Working with Washington Hospital Center in Washington DC, Microsoft was given access to 300,000 ER visits over a decade, and analyzed 25,000 variables to determine which variables best predicted readmission. Using this data, Microsoft was able to develop several different predictive models, including which patients visiting the ER would become inpatients within 72 hours and within 30 days, which patients discharged as inpatients would be readmitted within 30 days, and more.

  Microsoft then created a product called Readmissions Manager for Microsoft Amalga, which began shipping in June of 2011 to two hospital systems. The original product had 500 features. But this version posed a Sequel challenge. So, backing off a bit, a revised version was created with 23 features. The model is slightly weaker, but is engineered for the real world. This system provides a number to clinicians in real time, indicating the probability of readmission, and explains what variables it is seeing. This system is still early in its deployment, and much learning is being generated from in-world experiences.

- **Predictive models have great potential to decrease the number of medical errors.**

  Medical errors are another enormous problem in the healthcare system. The Institute of Medicine's report *To Err Is Human* attributed 44,000 to 98,000 deaths per year in the United States to preventable errors. Adverse medical events affect 13.5% of hospitalized Medicare patients, with 44% being preventable. And the cost of errors is estimated to range from $17 billion to $29 billion. A report earlier this year indicated that most hospital errors go unreported.

  An example of a predictive model that can improve safety is a system developed to detect anomalies in the treatment of cardiac patients. This system has been trained to predict outcomes for these patients, and the model is always running in the background, continuously predicting patients' outcomes based on the events it is seeing. If the system sees something unusual, it calls it to the clinician's attention.

  Another model that can be used to improve safety focuses on hospital-acquired infections, which affect 1 in 20 hospital visits, are a top-10 cause of death in the United States, and cost approximately $20 billion per year. A model can look at which physicians are treating a patient and how individuals flow through a hospital, and can use other variables to provide a probability for readmission. (This model wouldn't show causality.)

  As focused predictive models are developed, they might become SMART apps of the future.

- **One possible area for predictive models is identifying clinical surprise.**

  Physicians don't like being told what they already know. In the history of medical informatics, many systems have done just that, but such systems aren't terribly useful.

What could be more useful is complementing a physician's human knowledge by telling them something they don't know, and which would surprise them. For example, imagine a system running in the background that used data to determine and then inform the physician, "The patient you are discharging will likely return within three days with a primary diagnosis that is not currently on this individual's chart." Such information would certainly be surprising, could only come from a sophisticated predictive model, would impact the care provided, and could improve the outcomes.

> *"These kinds of models are built to complement human expertise."*
> — Eric Horvitz

- **Predictive models can be used to make decisions and set policies.**

  An important use of a predictive model is to decide whether to provide a specific intervention and to set policies. For example, congestive heart failure is the most frequent diagnosis for hospitalized Medicare patients. Nearly 10% of people over 65 have been diagnosed with CHF and CHF costs Medicare about $35 billion per year.

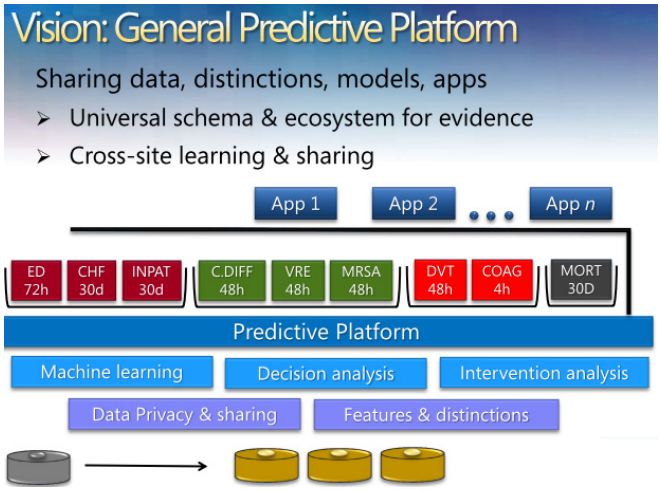
  There are a wide range of post-discharge CHF programs, with a range of reported costs and efficacies. An important question is whether a health system or payer should invest in a post-discharge CHF program for a patient or a group of patients. This is essentially a cost/benefit analysis that looks at the cost of an intervention and the expected value of this intervention in reducing readmission. Models can lead to decisions on the best policies.

  The best models will aggregate data across hospitals. That is because one study shows that 47% of CHF patients who are readmitted to a hospital are readmitted to a different hospital than the one from which they were discharged. (Medicare will be penalizing hospitals if a patient is readmitted, even if the person is readmitted elsewhere and even if the hospital doesn't know about the readmission.)

- **A vision for the future: a general predictive platform.**

  A general predictive platform is an idea that would have apps run on top of it. The platform would share data, distinctions, models, and apps. It would have a universal schema and would be an ecosystem for evolving evidence.

> *"Imagine if we had this [general predictive platform] as fabric, and built apps on top of it."*
> — Eric Horvitz



- **Data from sources other than EHRs can provide valuable insights.**

  Microsoft got access to geotagged mobile logs from 34,540 iPhone and Android devices. They analyzed several hundred thousand queries to see what people were saying and searching before ending up in a hospital. The idea is to develop a prediction about the likelihood of searching certain words (like "chest pain") and then going to an emergency room, and also to determine how long it takes a person to go to the ER after searching on certain words.

Questions, Answers, Discussion

- **Readmission linked to environmental factors.** Even though CMS has chosen to penalize hospitals for readmissions, a participant from Mayo said readmissions are often related to environmental factors and personal behaviors that are out of a hospital's control.
- **Acceptance by clinicians.** One participant mentioned that a model with 98% accuracy was likely to be accepted by clinicians, but one with 75% or 80% accuracy might be viewed as another distraction. Mr. Horvitz responded that models used today to set policies are often less accurate.
- **Small "n."** One participant worried that with genomic data providing unique data sets, the result may be models with limited data and a small "n." Mr. Horvitz suggested starting with the big cases where there is already a great deal of data.
- **Privacy.** One participant stressed that with growing amounts of genomics data, privacy is a myth. He believes the conversation needs to shift from "privacy" to "policy."
- **Haves and have nots.** One participant worried that the types of predictive models discussed will end up in large academic medical centers, creating a world of haves and have nots. She encouraged making such tools open so that all can benefit.

Apps & APIs Meeting Customer Demand for Physician and Patient Users

- Moderator: **Isaac Kohane**, *Henderson Professor, Harvard Medical School; Director, Boston Children's Hospital Informatics Program; Co-Director, HMS Center for Biomedical Informatics*
- Presenters: **Stanley Crane**, *Chief Innovation Officer, Allscripts*
  Sean Nolan, *Chief Architect and General Manager, Microsoft Health Solutions Group*
  Marc Overhage, *Chief Medical Informatics Officer, Siemens Healthcare*

Overview

There is great enthusiasm for open APIs that enable third-party developers to create applications that pull data from data containers and run on existing EHRs. But just having an API is not enough. There must be a platform with adequate core functionality on which to run an app. There must be a market so developers are encouraged to create apps. There must be a process for certifying apps, and for selling, installing, and supporting them. The panelists see no technical limitations to creating a standard API and all would support such an endeavor.

Context

The panel discussed linking EHRs to externally developed apps and the role of APIs.

To open the session, Isaac Kohane described the SMART app now in use at Boston Children's Hospital that provides real-time data on the centile a child's blood pressure is in. The ability to see blood pressure in a centile fashion as a child grows had been on the top priority list of the IT groups from the lipid clinic, the cardiology clinic, and the endocrine clinic for at least two years. The coding of this SMART app took just a few months, though getting the app into production took roughly one year. Dr. Kohane has never seen a foreign application work so seamlessly within a third-party vendor's system (in this case Cerner).

> *"This was for me a microcosm of the potential successes that we can have with apps."*
> — Isaac Kohane

Key Takeaways

- **Even large EMR companies see value in being able to connect to apps.**

  Marc Overhage said that Siemens has people at the company working to take advantage of its platform and implement projects similar to the example provided by Dr. Kohane. However, doing so often involves significant pain.

  But Dr. Overhage acknowledged that even a huge organization like Siemens, with 460,000 people, can't do everything. In some instances, a market may not be large enough to merit its attention and in other instances a large company may not have specialized knowledge in a particular area, such as genomics. Also, large companies may not move as quickly as desired.

  In thinking about a platform to serve as the foundation for various apps, Dr. Overhage offered the following thoughts:

  — *Sufficient functionality.* Even if there is a wonderful platform with cool apps, if it doesn't start with enough functionality, it is a nonstarter. Whether a platform is from a commercial vendor or is open source, there is a set of core activities that a platform must have.

  > *"If a platform doesn't start with enough functionality, it's a nonstarter."*
  > — Marc Overhage

  — *Developers' mental model.* There must be a mental model that developers can easily adopt. This is needed so a broad range of developers, including those who aren't steeped in a particular platform, are engaged.

  — *Publish-subscribe model.* To build apps that are going to make a difference in clinical care, there has to be a way to expose the data as it flows in a pub-sub model.

  > *"The way that we move data in and out of these applications is going to be at least as important as the applications themselves."*
  > — Marc Overhage

- **A key is making APIs that have critical mass.**

  Sean Nolan stated that traditionally vendors have hoarded data, and deep down, vendors don't like true substitutability. However, the number of vendors whose model involves trying to do everything themselves is shrinking.

  That has led to the creation of a huge number of APIs, which is good. The proliferation of APIs sparks innovation. The growth of APIs is an important step in providing distributed and federated applications in healthcare.

But just having an API is not enough. That is because developers are fickle. They go where there is critical mass and they care if there is a market. So, the challenge is creating APIs that have critical mass, which is a hard, long slog. Other considerations to attract developers are:

— *Being able to reach new markets.* Developers want to know if an API can help them reach new markets that they otherwise couldn't reach on their own.

— *Longevity.* When hundreds of apps are using an API, it is inappropriate to suddenly change the API. There must be backwards compatibility of the app and at the data level. This adds complexity but is important.

At Microsoft, there is clear recognition of the need for both clinician- and patient-facing apps—and overlap between them. Mr. Nolan shared an example of a project for Kaiser where a bridge was created between Epic and HealthVault that allowed Epic to provide a view to clinicians and care managers while allowing patients to use a tool developed independently by the American Heart Association.

> *"I get excited about actual end-to-end use cases that a fully integrated and fully connected world would start to bring."*
> — Sean Nolan

- **An open API empowers a third-party development community to build applications.**

  Stanley Crane previous worked at Ashton-Tate and could not understand how its imperfect dBASE product led the market. He came to understand that a third-party developer community had created a wealth of applications running on dBASE; for a user to run an application, they had to purchase dBASE.

  Allscripts has learned from this experience. In 2006 the company started building its own open API, and began training third-party vendors on it in 2007. Today about 25 companies build and ship applications using this open API, resulting in lots of smiling doctors and more loyalty and revenue for Allscripts. This is a way for Allscripts to innovate for its customers, by tapping into third-party developers who create new applications.

  > *"We continue to attract innovation and creativity. . . . How do we do this? We built this open API . . . to me, this is the wave of the future."*
  > — Stanley Crane

  Allscripts has essentially built a wrapper around its software. Allscripts could build a layer on top of its API and become a supplier of data for SMART. Allscripts' API is now five years old; it can read and write; and massive amounts of data can be pulled out through it.

But, winning in this market doesn't just require good technology. There has to be a way for potential customers to learn about and purchase apps, such as an app store. There has to be an entire infrastructure to certify applications, sell them, implement them, and support them. There also has to be a way to get data into apps and make sure there aren't security issues or performance problems.

> *"I want smiling doctors, not because of the code we wrote, but because of the code that the third-party development community wrote."*
> — Stanley Crane

Allscripts' vision is to push data to clinicians so they have it whenever they need data to make a decision. Allscripts views its job as taking care of the data, ensuring the integrity of the data, developing the business rules around the data, and then supplying the data to the rest of the world.

Discussion

- **API starting point.** The participants agreed with the approach of starting an API small and growing it incrementally. Mr. Crane said Allscripts adds to its API when customers need something. He is not aware of any applications using the Allscripts API that only extract data; all have some ability to write. Mr. Nolan conveyed the need to stand behind and support any API developed.
- **Business model.** Allscripts has different revenue sharing models based on which party does the selling and the install. But Allscripts' primary goal is to sell its EHRs. Mr. Nolan said HealthVault sees itself as a hub and ties its revenue to the value extracted from its platform. Dr. Overhage noted that Apple's app store is a relatively small revenue stream for the company; the store's primary purpose is to help Apple sell more devices.
- **Purchaser of apps.** While Mr. Crane sees no technical reasons why individuals couldn't purchase apps, but neither Dr. Overhage nor Mr. Nolan sees institutions as the purchasers of for the foreseeable future.
- **A standard API.** In response to a question about one standard API, with containers that allow sharing applications, Mr. Nolan thinks it is possible for SMART to be a standard API. He doesn't see a technical issue; the issue is user demand. Mr. Crane is also excited about the idea, believing that Allscripts will get credit from customers for any innovative apps running on its platform. A level playing field will be beneficial for the company.
- **User interface.** The participants were in agreement that they don't want to be the "UI police." But Dr. Overhage noted that there could be safety and liability issues around inconsistent UIs. (A participant asked if these issues would be any greater than issues today when clinicians work at multiple sites with different EHRs and different UIs.)

Keynote: The Future of Healthcare

- Speaker: **Clayton Christensen**, *Kim B. Clark Professor of Business Administration, Harvard Business School*

Overview

Innovation follows a repeatable pattern of moving from centralization, where only those with money and skill can buy and use a product, to decentralization, where products become simpler, less expensive, and more accessible. This pattern has occurred in technology industries and will occur in healthcare, albeit slowly.

When a product is new it is not "good enough" for most customers. At this stage, the companies that win have proprietary, interdependent architectures. (This is where electronic medical records are today.) But as a technology matures and becomes good enough for most customers, the winning architecture flips to an open, modular architecture and the component makers realize the greatest profits (i.e. Intel as a component in desktop computers). The theory of disruptive innovation says that this will happen with EHRs. This modular architecture will be receptive to substitutable apps and the best apps will have great value.

Context

Professor Christensen described his theory for a repeatable process of innovation that makes solutions affordable and accessible. He applied this theory to the healthcare industry and to electronic medical records.

Key Takeaways

- **Theories predict what will happen.**

  People often attempt to explain why something happened in the past and what will happen in the future through correlation. But more interesting is the scientific method, which focuses on causality. Professor Christensen tells his MBA students that he isn't interested in their personal opinion; he is interested in a theory. If a theory doesn't explain something, then the theory needs to be improved.

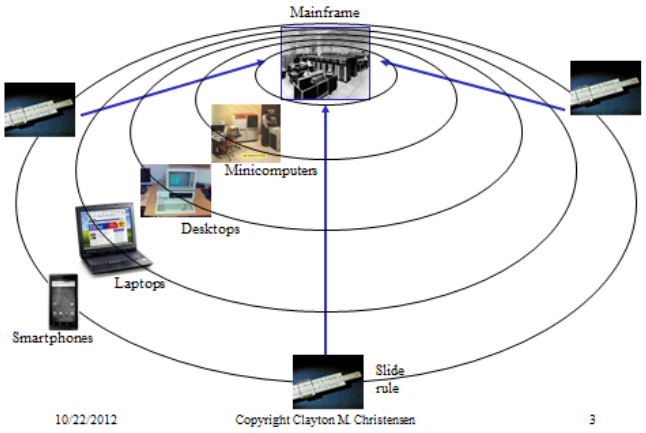
- **The theory of disruptive innovation explains the general process of products becoming more affordable and accessible.**

  Innovation follows a repeatable pattern of centralization and decentralization that can be understood through a series of concentric circles.

  Initially, the customers for a new technology, such as a mainframe computer, have money and skill. Then, a disruption occurs as an innovator develops a product that is less expensive and can be used by people with less skill. So, $2 million mainframes were disrupted by $200,000 minicomputers. Minis were disrupted by $2,000 desktops, which were disrupted by laptops, which in turn were disrupted by smartphones.

  At each stage, decentralization occurred as simpler, lower-cost products were developed for a larger market. And, at each stage, the leaders focus on improving their current product to better serve their existing customers. In contrast, the disruptive innovators focus on making cheaper, simpler products for a larger group.

The general process of becoming affordable and accessible



- **The right product architecture depends on the stage of competition.**

  Early in an industry, when a product is not yet "good enough," the winning companies will have proprietary, interdependent product architectures. To win at this stage, a company must do everything. IBM did everything during the mainframe era; Ford was vertically integrated and had a proprietary system in its earliest days, as did RIM with its Blackberry. At this stage, one company with a proprietary system competes with another.

  Then, when a product has matured and has become more than good enough, the architecture flips from proprietary to modular. In the desktop era, Dell and HP assembled modular components. And, the theory predicts that Android will overtake RIM and Apple. In a modular era, the profits are realized by the component makers—like Intel—and not by the makers of the entire system.

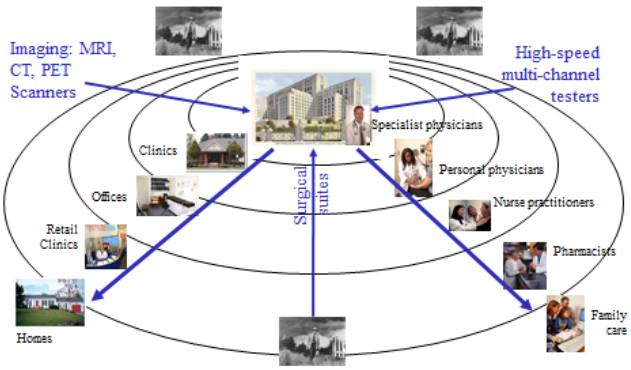
- **The theory of disruption applies in healthcare.**

  Healthcare is still highly centralized, as hospitals have expensive, hard-to-use equipment that can be used only by skilled individuals (specialists).

Lowering the costs and improving the access in healthcare won't come about by hospitals simply choosing to make less money. For disruption to take place, technology is needed that will enable care that is currently delivered by specialists in hospitals to be delivered by physicians in clinics; care that is delivered in clinics to be provided by nurse practitioners in offices; and care that today is provided in offices to be delivered by nurses and pharmacists in retail clinics. And, other technologies need to enable individuals to provide self-care in their own homes.

> *"We need to bring technology to enable lower-cost caregivers to deliver lower-cost care."*
> — Clayton Christensen

The decentralization that follows centralization is only beginning in healthcare



1. Bring the problem to the solution. 2. Then bring the solution to the problem.

The theory of disruptive innovation also explains the development of electronic health records. EHRs are still early in their development, and as such, are not yet good enough. At this stage, the winning companies will be those that are proprietary; not modular or open. They will force customers to conform with their architecture. And, they will be focused on adding features and improving their products to make their current customers happier.

But the market will mature, products will continue to improve, and at some point, the products will become more than good enough. When this occurs, a proprietary architecture will give way to a modular architecture, and components (in this case apps), will have the greatest value.

- **The way to think about developing products and marketing is based on the "job" people want to do.**

  Marketers often think about people's attributes and characteristics. They market to people who have a certain set of descriptive characteristics, such as a man who is 60 years old who has a certain income. But these attributes are not what causes a person to purchase a certain product. People have jobs to do in their lives, and they hire products to do the jobs for them.

> *"It is the job that we have to understand; not the characteristics of the customers."*
> — Clayton Christensen

When companies understand the job that a potential customer wants to get done, they can create a product or solution that helps the customer do the job.

An example of a job that clinicians want to get done is getting reimbursed. Solutions have been developed using electronic billing. Clinicians have embraced this, because it helps them get a job done that is important to them. Yet even with significant financial incentives, many clinicians have not adopted EHRs, or are putting data into EHRs but aren't really using them because at the moment, electronic medical records don't help clinicians do a job that they want to get done.

Other Important Points

- **Healthcare's architecture problem.** Today, only about 10% of the healthcare delivered in the United States is delivered in a proprietary, interdependent system, with examples including Kaiser and Intermountain. So, 90% of the healthcare in the United States is delivered in a modular fashion. The problem is that for a modular system to work, there must be concrete specifications, there must be clear measures of results, and there must be predictability. Since none of these conditions exist, most healthcare is currently delivered through the wrong architecture. The high costs and poor outcomes are a result.
- **Education.** Problems in the U.S. education system can be tied to not understanding the job that students want. Here is the job that students want to get done: they want to feel successful today. And, they could get that job done in several different ways: some "hire" school; others join a gang, get a job, or get a car. By understanding the basic job that students want to get done, educators can adapt their approach so kids want to hire school to get the job done of feeling more successful.
- **Health of diabetics.** About 80% of those with diabetes don't see "staying healthy" as a job they are interested in doing. But employers are interested in keeping their employees healthy. Employers may say to their diabetic employees that if they keep their A1C at a certain level, then $3,000 will be added to their health savings account, but if the A1C falls below a certain level, then the employer will have to pay higher insurance costs and the employee will receive less money for their HSA. In this way, an employer could be focused on the job they want to get done and could use financial incentives to try to change behaviors.

SMART-Enabled Platforms

- Moderator: **David Kreda**, *Business Translation Consultant, smartplatforms.org*
- Presenters: **Joseph Dal Molin**, *President, E-Cology Corporation; Chairman, WorldVistA*
  Travers Franckle, *Research Software Engineer, Indivo, Boston Children's Hospital Informatics Program*
  Carl Kesselman, *Professor, University of Southern California*
  Daniel Nigrin, *Senior VP for Information Services & CIO, Boston Children's Hospital; Assistant Professor, Harvard Medical School*
  Christine Park, *Project Manager, Mirth Corporation*
  Sims Preston, *CEO, Polyglot Systems*
  Nich Wattanasin, *Team Leader & Project Manager, i2b2, Partners Healthcare*

Overview

SMART has experienced many early successes. Organizations are SMART-enabling their platforms and developing SMART apps. Benefits of doing so include tapping into a community of innovative developers and being able to access current and future SMART apps. The process of becoming SMART enabled is seen as simple and straightforward. Importantly, this panel demonstrated the growing enthusiasm for SMART and confirmed that substitutable apps are possible.

Context

David Kreda summarized types of innovations SMART is doing to make those in the health informatics community aware of what is possible with a developer-friendly API.

Then, each presenter described their work with SMART technology, which has involved enabling platforms and developing apps. (The presentations are summarized in the order they were given.)

SMART

- **The SMART model aims to inspire innovation.**

  One of the challenges facing SMART is the chicken and egg issue, which is that platforms only come into existence because there is something that people really want.

  To try to address this problem, the experimental premise behind the SMART model is that the API and plug-in architecture are the highest priority. APIs are now extremely popular. The conventional wisdom among vendors is that APIs are the road to riches. The idea is to create a low barrier to develop applications, and on the container development side, to make it simple to spark the creation of an ecosystem.

> *"You don't just build a platform and your own proprietary thing; you almost immediately expose APIs."*
> — David Kreda

In the EMR market, where there are 600 different EMR systems, one question is how many different APIs should there be? Should there be 600? 50? 15? A fractured market has implications for developers. A different approach is to have a standard that everyone adopts, with HL7 being an example (though it is not very developer friendly). The key distinction that the SMART team has been focused on is creating a developer-friendly API.

With a goal of a developer-friendly API and simplicity on the container side, there are several ways that the SMART platform can be leveraged in the very near term. Examples of SMART activities include:

— *Pediatric growth charts.* The pediatric patient is different from the adult patient and EMRs have not addressed many important types of pediatric information, such as growth charts. SMART has engaged a design firm to come up with simple, compelling ways to visualize pediatric growth charts and is developing an app. If the app is well received, SMART will make sure that every EMR vendor sees it and could take the open source code and use it.

— *Diabetes monograph.* Partners has a longitudinal medical record system and a well-regarded EMR. But reviewing data about a diabetic patient required looking at 13 different screens, with lots of clicks and navigation. So, Partners consolidated all of that information on one screen, and that information could be provided to patients as a simple handout.

This diabetes monograph developed by Partners has now been turned into an app—the SMART Diabetes Monograph app. It is a clean interface and the app can provide a simple, clean, easy-to-understand handout to patients. Similar monographs can follow for other diseases, including asthma, breast cancer, and congestive heart failure.

— *Augmenting data reality*. Data can be brought out of an EMR and then used in multiple ways. For example, a clinician could see what guidelines were in place related to certain data or could do heuristics, looking at "what-if" scenarios.

Polyglot

- **The SMART API has liberated Polyglot to innovate.**

Polyglot is a small North Carolina company that won the SMART Apps for Health Challenge. In this competition, the SMART team created a SMART EMR and challenged software developers around the country to integrate interesting applications into the EMR using the SMART API. Polyglot took first place with its Meducation product.

Meducation addresses the problem that one-third of the U.S. population has low health literacy. As a result, there is poor adherence and compliance with drugs, leading to over 125,000 deaths per year, millions of hospitalizations, and almost $300 billion in spending.

Yet, a typical way that consumer medication information is presented involves information written at a 12th-grade reading level, in six-point font, in English. This information cannot be understood by many patients.

Polyglot provides patients easy-to-understand medication instructions in more than one dozen languages, with videos for some medications. Patients and clinicians like the information and product. But Polyglot has experienced the following problems:

— *Workflow issues.* Data must be manually entered about a patient's medications. Clinicians wanted the application to be integrated into their workflow and with their EMR so data wouldn't have to be manually entered.

— *EMR integration issues.* EMR vendors like the application but are busy working on meaningful use and addressing customers' requests. Integrating Meducation is not a priority. Also, integration with an EMR is expensive for Polyglot, strains its resources, and must be repeated for each EMR.

The conclusion is that Polyglot has an excellent product, but the go-to-market experience is slow, expensive, and potentially untenable.

The SMART API represents a solution. Using the SMART API Polyglot was able to integrate with the SMART EMR with just two days of development time and could demonstrate that Meducation's functionality and content can be used within the EMR's workflow with no data entry.

As a result of the SMART API, Polyglot was liberated to spend its time innovating. This included improving its product, adding features, and enhancing the user interface.

> *"The SMART API is a catalyst for innovation. It liberates small innovators to do more of the stuff that they really excel at."*
> — Sims Preston

Polyglot's one request to improve the SMART API would be to add write capability. For example, using the medication reconciliation interface to update the patient's drug list in the EMR database would be of tremendous value.

Virtual SMART (vSMART)

- **vSMART is a modular implementation of a SMART EMR container that works with an organization's existing EMR system.**

SMART-enabled EMRs, where the SMART API is integrated with an existing EMR, is one method of SMART deployment. But this requires the EMR vendor to be willing to go through this integration process. If the vendor isn't willing, SMART enablement can't happen. This is the problem addressed through vSMART, which decouples the SMART API from the ability to deploy apps using that API.

vSMART is a full, open source stack that is not bundled with an EMR. This is a modular implementation of a SMART container that allows users to connect SMART applications to an existing EMR deployment. It allows users to connect to SMART apps through regular web browsers that are not connected to a full EMR system.

> *"This allows you to use SMART apps within your environment without having to change the underlying system that's been operating."*
> — Carl Kesselman

vSMART uses several standard techniques. It is modular with a standard interface in front and three plug-in points on the back end: security adapters, data model adapters, and transport adapters. vSMART takes data from multiple sources and relies heavily on relational database technology; relational queries naturally support SMART APIs to get EMR record content.

SMART-Enabled Indivo

- **By SMART-enabling Indivo, users have access to Indivo's PHR, SMART apps, and write capabilities.**

Indivo is an open source, personally controlled health record (PHR) that enables patients to manage and control a digital copy of their health information.

The reason to SMART-enable Indivo is so that SMART apps can run on Indivo, providing the Indivo community with access to all current and future SMART apps. This also creates a broader developer community and allows all Indivo developers to become SMART developers. Also, this provides greater interoperability and there is value to Indivo in standardizing on the SMART API and data models. At the same time, Indivo is focused on retaining its sharing capabilities and its writing features.

> *"Indivo ends up supporting the SMART API, [and] keeps its existing rich writing, sharing, and admin APIs."*
> — Travers Franckle

In the end, a person running Indivo can access SMART-hosted apps, and users can still write to Indivo.

The challenges for SMART-enabling Indivo include finding the correct resources and libraries, and learning RDF. Also, SMART-enabling Indivo required that Indivo migrate models. This wasn't merely implementing a SMART layer on top of Indivo; it was rearchitecting Indivo and updating all surrounding components, including the user interface and existing apps, to consume the new data models. It also required significant testing and documentation.

Mirth Results

- **Mirth Results, which is becoming SMART-enabled, tracks the "footprints of a patient."**

Mirth Results is a clinical data repository that supports data aggregation and exchange for HIEs, hospitals, and other clinical settings. Mirth focuses on efficiently building a longitudinal patient record from various data sources. In doing so, Mirth emphasizes capabilities for data standardization and normalization. The product supports direct consumption of various message types and supports HIE standards for document submission and retrieval.

> *"You can think of Mirth Results as a storage box and you just pull stuff out as you need it . . . it tracks the footprints of a patient."*
> — Christine Park

Mirth Results' goal with SMART is to provide a SMART container for Mirth's HIE platform. In becoming SMART-enabled, Mirth's two strategies are:

— *SMART API.* Mirth Results already codes SNOMED and LOINC, but had to add a servlet to expose the SMART API, add converters to transform Mirth data into the SMART RDF model, and add additional code sets for the RxNorm. Also, code tables had to be added to map data to normalization and make OAuth work with a third-party API. This should be completed around November.

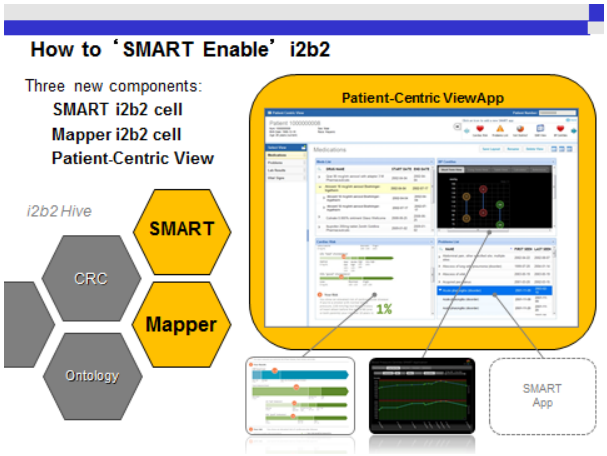
— *SMART apps.* To enable Mirth Results to run SMART apps started with adding support to save apps within the Mirth Results container, and also adding a container to be able to display the SMART applications. Integration with the patient page was also necessary. This idea is that Mirth Results users will be able to easily access SMART apps. This will provide the ability for substitutability, as apps can be added or deleted.

i2b2

- **i2b2 has become SMART-enabled and has developed an app along the way.**

i2b2 is software with a set of tools that allows investigators to query accounts or sets of patients on various criteria. i2b2 was built in a modular, extensible fashion and is now installed at 85 health centers and institutions around the world. Because i2b2 is modular, it was SMART-enabled without touching any of the core components.

One significant accomplishment has been SMART-enabling i2b2, which has involved container development (the server side). SMART-enabling i2b2 has meant adding three new components to the i2b2 "hive," which is shown below.



These three new components of the hive, which communicate with each other through web services, are:

— *SMART cell.* This implements the SMART API in i2b2 to produce the SMART RDF model. This cell registers apps (no rogue apps), and handles authorization.

— *Mapper cell.* This contains a mapping of local codes to SMART-preferred coding systems. Assistance is provided in the form of a starter table.

— *Patient-Centric View App.* This SMART app runs other SMART apps at the same time. Apps are selected from a carousel of installed apps and arranged into preferred views. This app was designed so that physicians can create views of specific patient areas of interest.

Among the lessons learned in SMART-enabling i2b2 are: the achievement of interchangeable apps is possible; implementation of the SMART model is straightforward; having to learn RDF for app development was a barrier, but SMART 0.5 eliminates the need to master RDF; and full HTML 5 compatibility is a challenge.

> *"Achievement of substitutable apps is possible; we've demonstrated it here."*
> — Nich Wattanasin

VistA/WorldVistA EHR

- **VistA has become SMART-enabled to tap into innovative developers.**

To date, VistA hasn't been able to tap into the energy of the broader developer community. By SMART-enabling VistA, the hope is to accelerate VistA innovation, make it easy for new developers to contribute, and leverage and reuse the work of others. Also, VistA looks somewhat old and antiquated; the hope is that SMART-enabling VistA will help VistA shine and will make it more informative.

> *"One of the motivations [for SMART-enabling VistA] is to increase the surface area of innovation, to make it easier for new developers to contribute and to be able to leverage and reuse the work of others."*
> — Joseph Dal Molin

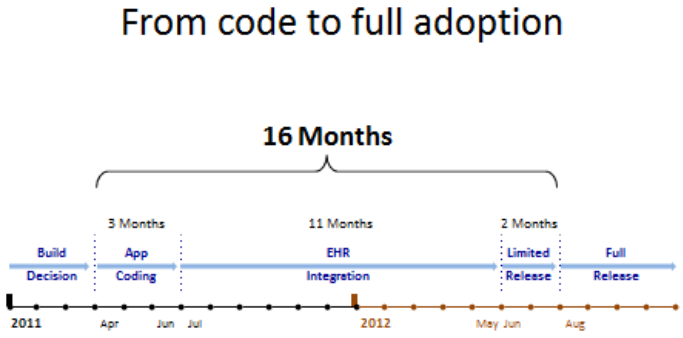
Thus far, VistA has been enabled to act as a SMART container. As a result, VistA's functionality can now be extended with SMART apps. In the near future, VistA will be releasing a virtual machine with a SMART-enabled WorldVistA EHR + EWD. VistA will continue working to expand community awareness and participation, and is interested in collaborating with other SMART developers.

SMART BP Centiles

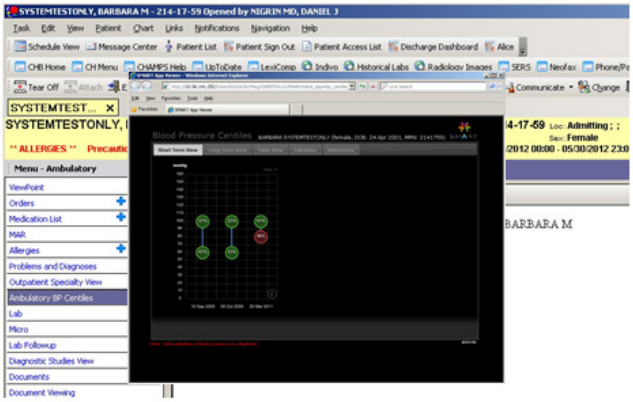
- **Boston Children's Hospital developed and implemented the BP Centiles app—and learned a great deal in the process.**

As was discussed repeatedly at this meeting, there was a real need at Boston Children's to provide clinicians with blood pressure information by centiles, but there was no commercial solution and the IT staff didn't have the bandwidth to implement a solution. Implementing a SMART app in the production environment, not as a proof of concept, would show the viability of apps.

The app and the data required were both relatively simple and straightforward. As the timeline below shows, building the prototype took less than three months. The integration into the hospital's existing Cerner system and the release of the app took far more time.



Today the BP Centiles SMART app is a menu item in Boston Children's Cerner EMR. Clicking on it launches a separate window, but there is no separate log-in and no patient look-up required; everything is managed seamlessly in the background.



In developing and implementing this app several things went extremely well. These include:

- Meeting a real clinical need.
- Rapid and effective app development by enabling developers to innovate.
- Breaking the dependence on the EHR vendor for UI development.
- Energizing clinicians who participated in the process.

> *"This broke our dependence on our underlying EHR's application for UI development. This was very important."*
> — Daniel Nigrin

At the same time, several aspects of developing and implementing this app were difficult:

- Multiple teams worked on this initiative and coordination among them was at times difficult.
- All of the constraints of a production roll-out existed, including change control issues, code reviews, security reviews, and more.
- Browser dependencies.
- Data issues.
- System performance issues, which weren't related to the app, but were still issues.
- Challenges mapping the SMART API to the EHR.

An important observation is that this app has a very different appearance than the underlying EHR. With 5 or 10 apps and no guidelines for look and feel, navigation, or usability, there could be problems.

More information about this app can be found at http://sandbox.smartplatforms.org/showcase.

Apps, Meaningful Use, and Accountable Care

- Moderator: **Kenneth Mandl**, *Director, Intelligent Health Lab, Boston Children's Hospital Informatics Program; Associate Professor, Harvard Medical School*
- Presenters: **Ken Majkowski**, *Vice President of Strategy and Innovation, Surescripts*
  Joshua Mandel, *Lead Architect, SMART Platforms; Research Faculty, Boston Children's Hospital Informatics Program; Instructor, Harvard Medical School*
  Shawn Murphy, *Medical Director of Research Computing and Informatics, Partners HealthCare Research Computing; Associate Professor, Harvard Medical School; Associate Neurologist, Massachusetts General Hospital*
  Jonathan Perlin, *President, Clinical and Physician Services and Chief Medical Officer, Hospital Corporation of America*
  Claudia Williams, *Senior Advisor, Health IT at White House Office of Science and Technology Policy*

Overview

Organizations of all shapes and sizes—from a large hospital chain, to the e-prescribing leader, to ONC, to i2b2 and the SMART team—are interested in an open API, apps, and making greater use of the wealth of data in healthcare, much of which resides in electronic health records.

There is much enthusiasm for the open SMART platform and there are many ideas for developing apps and using data to improve the delivery of healthcare. As Jonathan Perlin said, there is "an ecosystem of possibility." Moving forward requires dealing with data-related issues and forming a consortium of those focused on this space to deal with policies, standards, strategies, business models, and issues such as data privacy and security.

Context

The presenters each made a short presentation about the ecosystem for SMART apps, how apps are developed, and how this concept can scale.

Key Takeaways

- **Ideas exist to build out SMART containers in a more scalable way.**

  Joshua Mandel summarized the many early successes of the SMART project that have been shared. But a question that often comes up is around the need for multiple one-off integrations. People have wondered whether the work to build out SMART containers could be leveraged. One approach is vSMART (described previously).

  People also ask about fueling a SMART container not with a custom integration but with data export capabilities. The SMART team is looking at this. The following things would need to happen to build this system at scale:

  — *Meaningful use stage two.* This provides that systems are able to export documents under certain conditions with certain information, such as a problem list, a medication list, and more. This provides a baseline on which to build.

  — *An export trigger.* As thinking takes place about building a pipeline where data flows into EHRs, what is missing —and is needed—is a trigger that kicks off the data export process.

  — *Determining what data to export.* When documents are exported, it is clear which sections the document has. For example, there is a problems list, a medications list, lab values, and so on. But it is not always clear which problems should go on the problems list. Should it be all problems in a patient's history or just recent problems? The general trend is to provide summary data to avoid information overload. But app developers will want as much data as possible, and the app can figure out how to deal with information overload.

  — *Heterogeneity of document interface.* There will be a great deal of heterogeneity in how the documents that are exported actually look. Of value would be a library of sample documents from EHR vendors that cataloged the diversity.

- **There are many valuable ways that data in the health system can be put to greater use.**

  Surescripts is an e-prescribing infrastructure connected to about 450,000 e-prescribers and 60,000 pharmacies in the United States through more than 250 applications. These apps are also connected to payers who provide data for about 250 million covered lives. Each day the company sends out 2.5 million medication histories from pharmacy claims databases and from dispensed pharmacy data. This represents an amazing amount of data, but today, little if anything is done with this data.

  > *"I don't know what happens to most of that data . . . I don't think anybody does anything with that data."*
  > — Ken Majkowski

Many opportunities exist to better leverage this data, possibly in SMART apps, in ways such as:

— *Using eligibility transactions as a trigger.* When a patient whose payer uses Surescripts goes into a physician's office, an eligibility transaction is triggered that allows Surescripts to query where the patient has pharmacy benefits. But this transaction represents an opportunity to say to someone, "A patient is seeing a doctor face-to-face today." This knowledge could lead to a certain action, conversation, or intervention.

— *Medication reconciliation.* Surescripts data can be used to assess if a patient has filled the medications on their medication list. A specific opportunity may be in the first 30 days post discharge.

— *Medication management.* Surescripts also has data about which prescriptions are filled, where they are filled, and when they are filled. Information could be provided to a clinician showing if a prescription was or was not filled, if a 30-day prescription is regularly filled every 30 days, or if it is filled less frequently.

> *"I think medication management is a real opportunity."*
> — Ken Majkowski

— *Immunizations and vaccinations.* Historically, immunizations and vaccinations were administered in doctors' offices. But last year 20% of flu shots were given in retail pharmacies, and Walgreens, CVS, and Walmart now give up to 20 different vaccinations. Providing these services in communities has many public health benefits. But there needs to be bidirectional connectivity so clinicians know which shots a patient has received, as do pharmacists who are giving such shots.

> *"The opportunity to think about how an apps platform might serve those needs to develop a bunch of patient-facing, clinician-facing, pharmacy-facing apps is a fertile area for companies and app developers to think about."*
> — Kenneth Mandl

- **i2b2 provides an analogy for SMART and shows what is possible with an open platform.**

It was clear to those who developed i2b2 that they would not be able to think of all of its potential uses. So, they focused on making it a modular system to which others could add. And others have added and added, using i2b2 in amazing and unanticipated ways, such as for meaningful use queries.

SMART should be thought of similarly. It is an avenue for app developers to come in and write peripheral applications that EHR vendors aren't focused or working on.

> *"The EMR vendors aren't going to provide [apps]. They don't have the resources to do it; it's not going to happen. It is going to happen opening up a platform to app developers like we have in SMART."*
> — Shawn Murphy

App developers don't need much. They need some hooks into the data, a market, and reassurance that the market will persist and their effort won't be wasted.

- **There is an "ecosystem of possibility" with a role for both large EHR systems and applications.**

The healthcare system is undergoing a transition. Fee-for-service reimbursement is shifting to models of value-based and performance-based reimbursement. There is greater use of data and analytics. And providers are focused on meeting the meaningful use criteria.

Within this changing environment, there is great heterogeneity. The practice of medicine is organized very differently in different parts of the country. The data is also heterogeneous, with many types of old systems and niche products still in production environments. An indication of the heterogeneity of data is that HCA—with 170 hospitals, 150 outpatient centers, and 850 physician practice sites—produces about 800,000 one-off reports.

For clinical delivery, accountable care, and meaningful use, HCA wants systems that interoperate. They want the ability to continuously provide health data to inform care across time and geography. They want technologies that feed data into an electronic ecosystem and provide real-time decision support. And they want to automate performance reporting. They also want to mix clinical, financial, and predictive modeling data to make risk decisions.

HCA's IT strategy in this environment is to provision replacement applications and to provide an API where power users can develop their own apps. HCA's goal is to have an app store that includes user ratings.

> *"Our goal is to have an app store complete with . . . ratings and the ability to have some sort of curation capacity."*
> — Jonathan Perlin

Even though relatively speaking, HCA is a large organization, HCA is not an academic environment and does not have a deep development shop. It is more of a production environment, with an interest in balancing large interdependent systems with modularity. HCA sees a rationale for big systems, but also sees value in applications that can be appended to these systems. Based on the readiness of many of the SMART apps, Dr. Perlin can definitely envision these apps being available within HCA.

- **Meaningful use and standards for interoperability are gifts to be used by the HIT community.**

  In her ONC role, Claudia Williams described two gifts and one opportunity, and made one request.

  — *Gift #1: Meaningful use.* Meaningful use should be viewed as a gift in that it assures universal implementation of certain requirements across all EHRs. And this gift is growing as adoption of EHRs in hospitals is expected to triple within three years and this year 50% of the care in hospitals will involve EHRs.

  In stage 2, meaningful use will go even further with single standards for most clinical concepts, including problems, meds, lab results, and vitals. This is a gift in that developers can build on this foundation to create a thriving infrastructure of apps and tools to improve the care that is delivered.

  — *Gift #2: Interoperability framework*. The model that has been developed and the standards and interoperability framework are another gift.

The opportunity is for the HIT community—not ONC—to loudly say what the community wants. This can include an open API and building on the work of SMART.

> *"These gifts are here for your use, but they require the folks here, not at ONC, to say 'this is something we want today' and to take the first steps in that direction. And then certainly there are ways to build that into policy."*
> — Claudia Williams

The request is that the healthcare system evolves to better, cheaper care and as new technologies are developed, it is essential to continue to deliver care to patients in a safe and secure manner.

Discussion

Ken Mandl asked participants to share their thoughts on how to spark the creation of an apps ecosystem and community. Some of the comments are summarized below:

- **Consortium.** Dr. Mandl introduced the idea of a consortium and heard enough interest in the idea that he plans to proceed and explore how to take this concept to the next level. Everyone who is interested in participating should contact him.

- **Funding connectors.** One participant suggested focusing on containers by funding the development of connectors between the 300 to 600 EMRs and HIT platforms. Such connectors could stimulate the network effect and attract developers. (Dr. Mandl mentioned that the SMART team has actually discussed the idea of a container challenge.)

- **Certification.** Just as meaningful use has a certification process for EHRs, there may need to be some sort of vetting or certification process for apps.

- **Open data model.** An incredible amount of time and effort is focused on mapping and translating data. Open data models would be a leap forward and will enable SMART containers and SMART apps.

- **Access to data.** A challenge for app developers is the lack of access to data for use when developing apps. A sandbox with de-identified data for one million patients would be extremely valuable.

  One idea was that once per year all sites using EHRs has to extract a portion of their medical record data that would be de-identified and placed in a safe harbor. This would become a national resource that could be used by app developers in the development process. It could greatly accelerate innovation.

  Another idea was that 18 federal agencies are already at work on an innovation sandbox that might have EHR data from the VA and many other government sources. (When asked, almost every attendee expressed interest in having access to this data/sandbox.)

- **Data security.** An issue with apps in general (not specific to SMART) has been the leaking of data, which is unknown to consumers. This is more an issue of data security than data privacy. The magnitude of risk is enormous, which requires building hardened controls into any app to ensure that data isn't leaked. (Dr. Mandl sees this as a policy issue, a certification issue, and a selection issue. CIOs won't allow apps to be used by their organizations if they have any doubts about data security. A key question is where in the ecosystem data security is addressed.)

- **Movement away from physician centricity.** Because the delivery of healthcare is so physician centric, most discussions of EHRs and apps focus on their use by physicians. But as Professor Christensen pointed out, disruption in healthcare will take place when technology enables care to be delivered in locations such as clinics, pharmacies, and homes by non-physicians, such as nurses, pharmacists, and even individuals. Data is needed for each of these caregivers in all locations.

- **Features required.** One participant commented that the key features that are currently missing from the SMART platform are the ability to write, not just read, and the ability to see cohorts. (Dr. Mandl said that being able to write is on the roadmap and cohorts are currently left in the realm of i2b2).