



Product Introduction

Vision

Herald is on a mission to make healthcare safer by offering clinicians real-time access to clinical data exactly when and how they want it.

Problem

Adoption of electronic medical records (EMR) systems has been widespread, due in large part to government incentives. In theory, EMRs provide a digital platform to deliver enormous value for patients - from collecting more data to delivering intelligence based on that data to providers. In practice, however, providers are often frustrated with the solutions they have available to them, face a data overload problem, and spend precious time wading through clunky software interfaces.

In part, this is understandable. Modern medical care uses dozens of information systems to collect and display clinical data including labs, radiology, vital signs, provider notes, and more. Providers face the daunting task of monitoring each of these data streams, often in a “pull” mode periodically checking for the arrival of new data. Important information is frequently missed, leading to delays in care and threatening patient safety. In fact, the Institute of Medicine has identified untimely access to clinical information as a leading contributor to **at least 200,000 deaths and \$20 billion dollars in waste each year** during interactions with the health care system. The same study showed that physicians spend roughly 12% of their time retrieving information from their electronic medical records, which is the same amount of time spent interacting with patients.

It is therefore no surprise that well over half of doctors “dislike” or “strongly dislike” these systems. Existing systems are better optimized for billing rather than patient care or the physician experience. Our belief is that the enormous potential of healthcare IT solutions will only be unlocked when physicians are much more engaged and genuinely feel that the product they are using makes them more efficient, effective providers. No one has developed a great end-user experience in this space; Herald will change that.

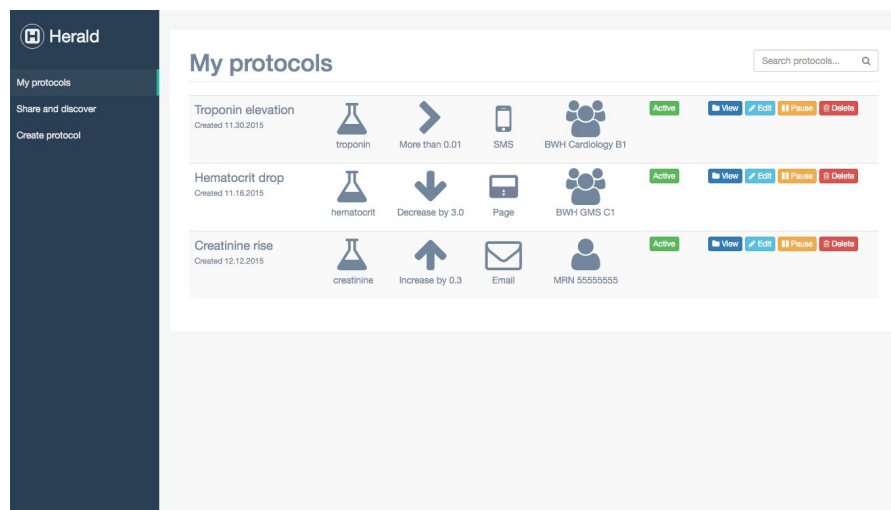
Solution

Herald is a software platform that will help unleash the value of electronic medical records. Herald delivers the critical medical information providers need - when and how they want it. It empowers clinicians to customize alerts based on real-time data from the EMR, thereby transforming the current “pull” model into a “push” model. This saves providers time and allows them to selectively filter for the data most important to improving patient outcomes.

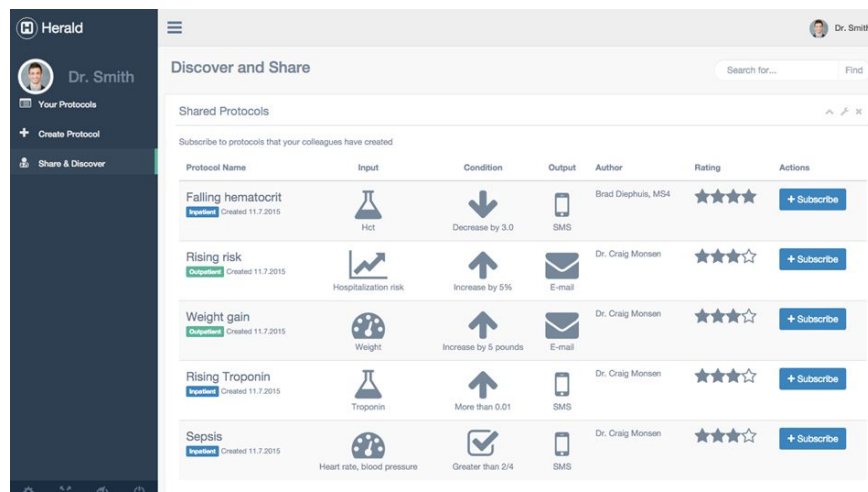
Herald is modeled after the popular IFTTT (“if this, then that”) consumer website that combines open APIs to create novel functionality. For example, one popular protocol combines the “Weather” input with the “Text message” output to produce “Send me a text message if it is going to rain later today.” In the clinical setting, inputs may include labs, radiology reports, or provider notes. Outputs represent communication devices including pagers, email, or text message. For example, a hospital-based cardiologist may create a protocol that pages her whenever one of her patients’ troponin (a marker of heart damage) rises, allowing her to take swift action. Another protocol informs a primary care doctor via email when her patient is admitted to a nearby hospital.

Protocols are constructed within seconds via an intuitive web interface. They may be rated and shared among providers allowing for crowd-sourcing of best practices. **A demo of our software can be found at: <http://alpha.heraldhealth.com>.**

A screenshot of “my protocols,” which includes all protocols a Herald user has created and adopted:



A screenshot of “share & discover,” a feature allowing Herald users to discover and easily subscribe to the most popular protocols among providers at their institution.

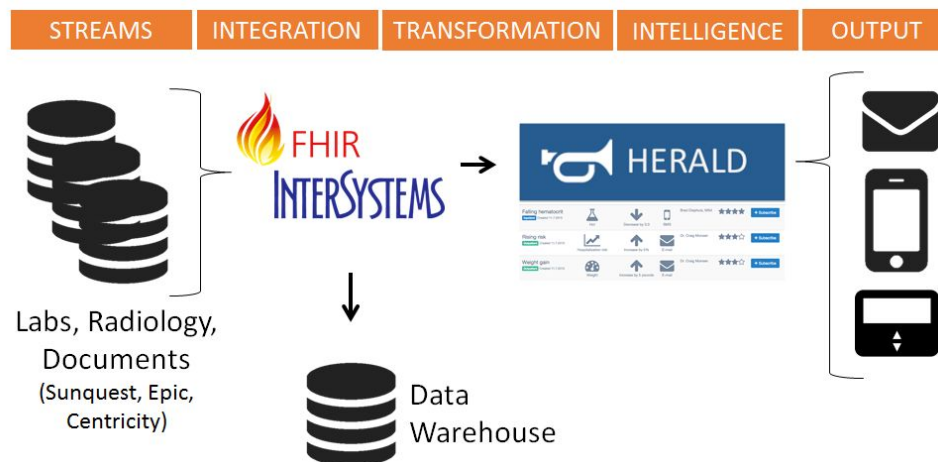


Technical Details

Platform Overview

Herald leverages integration APIs such as FHIR in order to fit seamlessly on top of existing electronic medical records. Healthcare IT solutions implementing FHIR's publication/subscription standard (eg InterSystems' HealthShare) are capable of directing data streams to the Herald software service. Serving as a HIPAA secure data endpoint, Herald software runs data transformations and business intelligence based on the protocols developed by clinician end-users. Relevant data is then passed through to users in real-time using their preferred output modality whether that is email, secure text message, or page. The diagram below tracks at a high level the data value stream from raw, siloed data through integration, transformation, application of intelligence rules, output, and ultimately action with the help of FHIR and Herald.

An overview of Herald's integration into existing information systems allow clinicians to get real-time data however they want it.



Pilot Specifications

For our proposed pilot, Herald will accept inputs from three sources - laboratory data, radiology reports and ADT feeds - and allow outputs over three modalities - secure paging, internal e-mail and HIPAA-compliant text messaging. For laboratory data, Herald will allow users to create protocols on the 60 most common lab orders. All inpatient lab events will be routed to the Herald server which has been load-tested to handle this volume. Laboratory data is complex and we have created a mapping of LOINC codes to our internal lab concepts with the help of our partner, Brigham and Women's Hospital. ADT (admission, discharge and transfer) data will also be sent to our server for clinicians to create rules based on movement of their patients within the hospital. Finally, all inpatient radiology reports will be routed to the Herald server, allowing physicians to receive notifications when critical diagnostic imaging has been performed. All of these data sources will be delivered using the InterSystems HealthShare integration engine, meaning that we can relatively easily expand to the many hospital systems already using InterSystems technology. **Critically, we have already received all necessary approvals to access all of these data sources at Brigham and Women's Hospital for our initial pilot.**

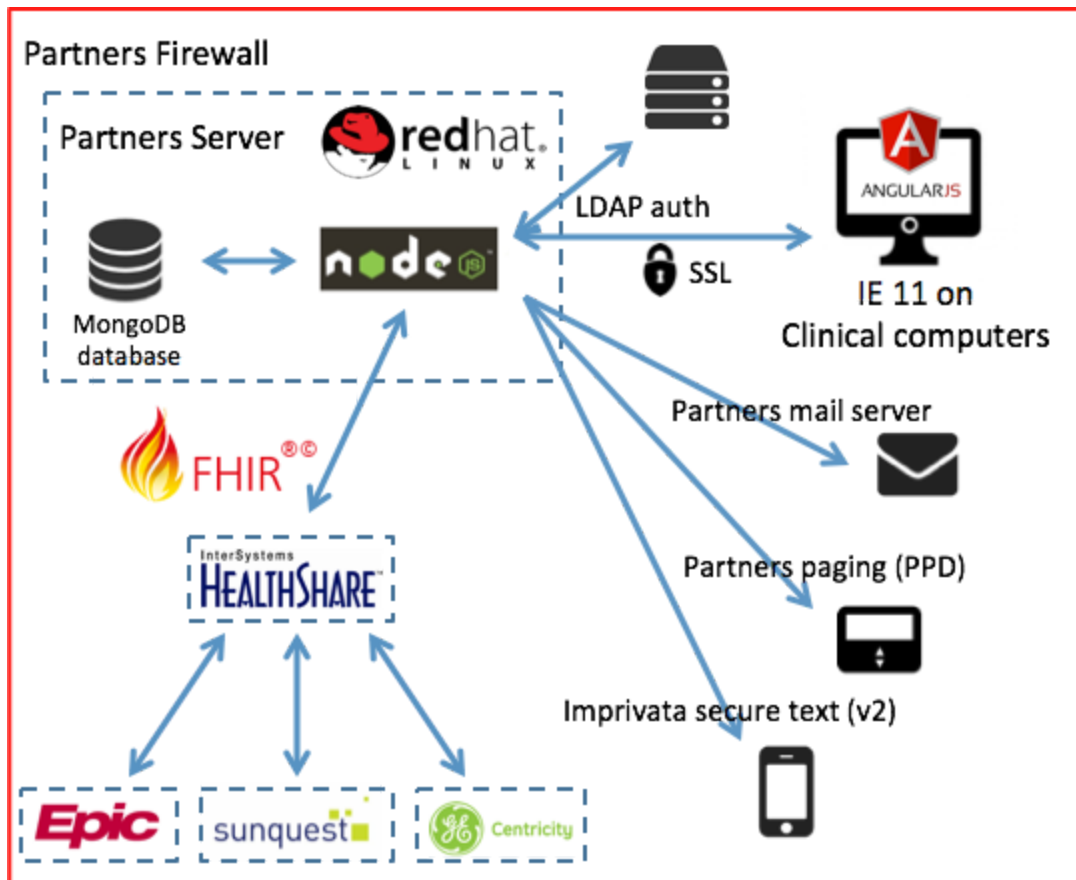
Technical Architecture

Herald is implemented using the popular web development technology stack known as MEAN (MongoDB, ExpressJS, AngularJS, and NodeJS). MongoDB is a NoSQL database store with support for secure, SSL-encrypted connection and encryption at rest. ExpressJS and NodeJS are a web framework and non-locking, thin server combination that allow creation of RESTful API-based apps with high concurrency. Both are implemented in Javascript. AngularJS is a popular client-side development framework written in Javascript and supported by Google.

In addition to the components of the MEAN stack, the figure on the following page illustrates other elements of a successful Herald deployment. The example used below is for the Brigham and Women's Health Care (BWHC) deployment in 2 hospitals. These hospitals are part of the Partners HealthCare system and so are referred to as "Partners" below. Herald is implemented to be entirely self-contained within a health system's firewall as denoted by the red line surrounding the system components. MongoDB, ExpressJS, and NodeJS sit on a Red Hat Enterprise License server within the Partners firewall. This server acts as an endpoint for the FHIR subscription data feed implemented by InterSystems. InterSystems is an integration engine that pulls data from the various hospital information systems at BWHC including Epic, Sunquest, and Centricity. After Herald receives data from the FHIR data feed, it passes the data through a business intelligence layer and ultimately to the user outputs as defined in the user-created notification protocols. Data are sent through encrypted channels in all cases.

Users access the Herald interface on clinical workstations through an SSL-encrypted, API-based JSON web token (JWT) login mechanism. While performing the JWT handshake, the Herald server authenticates a valid user using the Partners LDAP server and passes back a token that is continuously refreshed as long as a user remains active on the site. The interface is generated dynamically on the client side by AngularJS based on the data from the server's RESTful API.

Architectural diagram of Herald as it exists within the Partners firewall at Brigham and Women's Health Care



Security and HIPAA compliance

Herald Technologies takes patient privacy and data security very seriously. Though Herald acts as a mediator for patient data, we have made the architectural decision that **no patient data or personally identifiable information are actually stored on the Herald server** in order to minimize security risk. Instead, the Herald server receives an ongoing and encrypted data feed and makes on-the-fly FHIR-based calls for additional data as needed to evaluate protocols, and then immediately discards the data. Furthermore, data output will only take place on HIPAA-compliant channels - for example, internal e-mail, secure paging or specialized HIPAA compliant text-messaging services like Imprivata. We will never approve output channels such as standard SMS or external e-mail that are not properly securable.

Despite the lack of PHI on our server, we still follow the most robust security practices to minimize risk of any HIPAA breach. User data are natively encrypted at the MongoDB Application Level. Moreover, each data transfer is encrypted via SSL. Logins and CRUD actions to the database are audited, another feature native to MongoDB's WiredTiger storage engine. Finally, access control is enforced at each level of data access including operating system, database, and data transfer services.

Provider Partnership and Go-to Market Strategy



We have secured a critical provider partnership with Brigham and Women's Hospital (BWH) to advance our product. Our concept was born at a BWH hackathon last fall, and we have turned initial relationship into an official co-development contract with the hospital. We are providing the software development and product management, while BWH is providing access to their informatics infrastructure, clinical safety expertise, and crucially, access to pilot population. This provider relationship has proved invaluable to our team and we are excited to continue working with this premier academic institution. A **letter of support from the Chief Information Officer at BWH**, Adam Landman, is attached to this application.

We have developed a go-to-market plan to rapidly test our most risky hypotheses. A critical assumption is that by designing a frictionless user interface, we can make a product that providers eagerly adopt. We have validated this through robust user research, evidenced by the reactions of our focus groups, which have transformed from “interesting concept” to “When can I have this?” as Herald has evolved. We are now testing provider adoption *in vivo* via a **pilot implementation at the Brigham and Women's Hospital with a launch date of June 20, 2016.**

While early phases of the pilot will focus on user adoption, we will also develop value metrics that demonstrate the return on investment which we will deliver to client hospital systems. These value metrics will measure physician time saved and improvement in surrogate outcome metrics, which can both be translated into savings to the hospital bottom line.

We are also developing our pilot software in a modular fashion on top of **InterSystems HealthShare**, an established health information integration engine. We have also been in talks with Redox, another company that offers a FHIR-based API for EMR integration. These platforms serve a dual purpose. First, they provide a common interface to access patient data across a variety of EMR deployments. Second, due to their broad reach, they offer a natural distribution network with preexisting hospital relationships that can be leveraged to scale Herald across multiple healthcare systems.

Finally, after being selected as one of the winners of the athenahealth More Disruption Please Innovation Challenge, we have engaged with athenahealth about opportunities for collaboration. The athenahealth MDP Marketplace allows end-users to select add-ons to their EMR product, and thus could provide Herald with a robust sales channel to a growing number of physician practices.

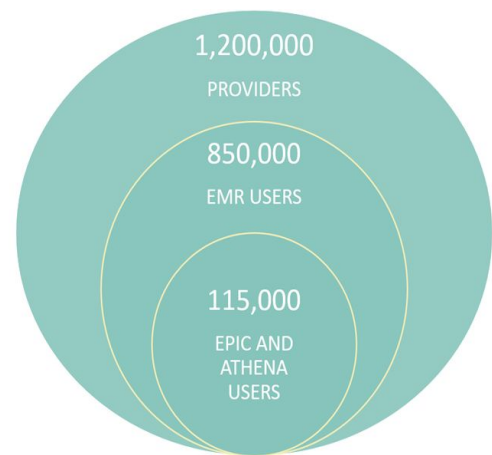
Business Plan

Target Customer

Herald is designed for doctors but will be purchased by health systems or practice administrators. Our target end users are therefore doctors that value the efficiency gains offered by Herald within health systems that value its economic benefits. Our user research and initial pilot opportunities have pivoted our initial focus to the inpatient setting, in which doctors are clearly struggling with data overload and require timely access to information. Inpatient physicians have shown the greatest demand for Herald and will have lower barriers to adoption. Our target purchasers are health systems that are entering into value-based risk contracting through bundled care payments or accountable care organizations. For such organizations, we plan to use our pilot to show that Herald has not only a benefit in physician satisfaction and efficiency, but also a hard ROI via shorter length of stays, reduced error rates, and improvement in guideline adherence. Within a value-based care framework, these metrics have a direct impact on reimbursement rates and system profitability.

Market Size/Dynamics

Herald's interoperable platform will enable us to sell to physicians across several of the major EMR systems. Through the upcoming pilot phase, we are focusing on development for the 115,000 Epic and athenahealth users—leading systems in hospital and outpatient settings, respectively. For price benchmarking, comparable efficiency-boosting and error-reducing medical software packages charge \$50-\$200 per provider per month. Using these values, there is a total addressable market of \$70-280 million within Epic users alone and \$500 million - \$2 billion across all EMRs. We expect to be on the higher end of these ranges over time as proven outcomes generate higher willingness to pay.



Revenue Model

Herald will improve provider efficiency, provider satisfaction, and quality of care. Reducing the 12% of time physicians spend retrieving data from the EMR will enable physicians to spend more time on value-adding tasks, including more patient-facing time. Given studies that calculate physicians' contributions to hospital and health system revenue to be approximately \$1.4 million on average, it is clear that even modest boosts to provider efficiency could yield substantial gains. **For a 1% boost in provider efficiency, Herald stands to create at least \$7,000 in value per physician per year.**

Treatment delays are a significant contributor to medical errors and healthcare costs. By shortening the time for providers to learn of adverse test results, Herald can facilitate quicker interventions to improve quality of care and potentially save lives. Shortening or eliminating lags in care can also create direct economic benefits for hospitals and health systems. A significant number of patient discharges and transfers are held up pending the return of negative test results. Automated rules to alert practitioners in real-time that the appropriate benchmarks have been hit will reduce length of stay for these patients,

which has the dual benefit of improving efficiency metrics for the hospital and reducing the risk of hospital acquired conditions. As an example to quantify this upside, shortening average length of stay by 30 minutes for only 10% of discharges at BWH would result in annual savings of about \$250k.

Because our minimally viable product is limited to relatively simple functionality in an inpatient environment, we anticipate Herald's potential to create value to substantially increase with future iterations of the product. Specifically, building for expanded use cases, for applications such as outpatient clinics, urgent care centers, and even pushing patient-generated data from wearables and other connected devices, will result in an increasingly robust value proposition.

Using the aforementioned competitor set as comparables suggests a range of pricing models. Most tools are sold through a SaaS model, but monthly fees per provider per month range from \$50 to \$200. While launching Herald in the EMR add-on marketplace would push us to the lower end of this range, proven savings and improved outcomes through our pilot phase will create significantly higher willingness to pay. Additionally, data we gather in our pilot phase will support the value creation projections we described. Herald's pricing model will be set to claim only a modest portion of this value, creating a compelling **return on investment for customers of at least 5x.**

Herald has a low variable-cost business model. Once the platform is built, our embedded crowd-sourcing function allows us to continually expand our sets of protocols at virtually no cost. Most ongoing expenses will relate to selling and marketing Herald. The product can be offered through vendor platforms (e.g., athenahealth Marketplace) for a share of revenue, which substantially lowers SG&A. We need to test whether a direct sales approach to large integrated health systems (such as Partners) is feasible and cost-effective. Ongoing conversations with clinicians and administrators is helping to inform that decision.

Competition

Today's provider experience is plagued by cumbersome and repetitive tasks. Physicians routinely write out task lists on index cards or notebooks to keep track of test results or changes to patients' medical record. Herald will compete against these ingrained processes, but its ease of use and ability to save time and improve reliability will give it a clear edge over current manual processes.

In terms of developing a product like Herald's, EMR vendors are the clearest potential source of competition. They could build a platform similar to Herald as an add-on feature. However, EMRs are optimized as revenue cycle management tools and are not sensitive to physician workflow, while Herald's core mission is to improve the provider experience. Even if EMRs tried to enter this space, their brands suffer from a lack of trust by providers and have not developed the competencies to design to provider needs. We also face competition from new entrants to the clinical decision support and population health management spaces. However, these are typically enterprise-wide solutions and are difficult or impossible to customize at an individual level. We believe that Herald is unique in its ability to crowd-source solutions from front-line providers, who are in the best position to optimize care delivery.

Progress to Date

The Herald team came together last fall. We started with an idea, which through intensive user research evolved into a clearer vision of the product. We organized several focus groups among doctors, and then conducted visits to outpatient and inpatient settings to develop use cases and learn more about clinician needs. In November, we competed in the Brigham and Women's Hospital Hackathon, where we developed our first prototype of the product and won the competition.

Coming out of the hackathon, we pursued three tasks. The first was to find customers. The Brigham was interested in having our product live in the hospital and we are currently implemented Herald as a pilot. In addition, we have begun reaching out to other providers and built a website (www.heraldhealth.com) to provide potential customers with more information about the product.

The second task was to further develop our prototype into a full MVP that could be deployed in the pilot. Through December and January, we restructured our front-end web interface. Since then, we have been working with BWH to integrate with their HealthShare-based backend so that clinicians can begin using the Herald product starting June 20, 2016.

The final task was to begin formally building as an organization, including incorporation in January. We've also participated in a number of area competitions. We were **grand prize winners in the Harvard Deans' Health and Life Sciences competition**, winners in the HBS Rock Accelerator as well as the athenahealth More Disruption Please Innovation Challenge, semi-finalists in the MIT \$100K challenge, finalists in the MIT Sloan Healthcare Case competition and were selected into Harvard innovation lab's Venture Incubation Program.



Harvard
innovation lab



Team



Brad Diephuis

Brigham and Women's
Hospital, Resident in
Internal Medicine



Matt Fujisawa

Harvard Business School



Andrew Hillis

Harvard University and
Harvard Business School,
PhD Candidate



Craig Monsen

University of Washington,
Fellow in Clinical
Informatics

The Herald team has a diverse range of technical, business and design skills combined with the clinical experience necessary to make Herald successful.

- Brad Diephuis is a resident in primary care and population health at the Brigham and Women's Hospital. He recently completed his MD and MBA degrees at Harvard Medical School and Harvard Business School, respectively. He is also a software engineer by training. As CEO, Brad's background in clinical medicine, technology and business allow him to coordinate across domains necessary for Herald's success.
- Craig Monsen is a health tech entrepreneur (check out symcat.com) and full stack web developer. He is a Fellow in Clinical Informatics at the University of Washington School of Medicine, and he recently completed his internal medicine residency at the Brigham and Women's Hospital. He has both the product development background and real-world clinical experience to make Herald a joy for clinicians to use.
- Leading our business efforts, Matt Fujisawa has deep experience in 5 years working in strategy and business development for one of the nation's largest medical centers. His extensive insight into the process of selling to hospital systems will be vital to Herald's transition from the pilot phase to commercialization. He recently completed his MBA at Harvard Business School.
- Andrew Hillis is a PhD candidate in health care economics at Harvard with a focus on big data and machine learning. He leads our efforts in user research as well as developing robust analytics around our protocols.

Visit <http://alpha.heraldhealth.com> for a live demo of our submission.