Immunization Calculation Engine (ICE)

An Open Source, Multi-Jurisdictional, Standards-Based Immunization Decision Support System Leveraging the OpenCDS Platform

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1. Background

Ensuring that patients receive all of their proper immunizations on a timely basis is an integral aspect of preventive care and public health. However, as the number of vaccines continues to grow, it is becoming increasingly challenging and impractical for healthcare providers to consistently adhere to best practice guidelines that are complex and regularly updated.

Computer-based clinical decision support (CDS) can be an effective strategy for improving the quality of care. However, many clinical healthcare systems lack CDS. Furthermore, organizations that attempt to implement immunization decision support within their healthcare information systems discover that it is difficult, time consuming, and costly to maintain.

The healthcare industry needs a free immunization forecasting system that can be easily integrated with other systems, comes pre-configured with best practice rules, is flexible, and can be maintained without software developers.

2. Method

A collaborative partnership of public health experts and information technology experts from several organizations are developing an open source, state of the art immunization forecasting software system, named the **Immunization Calculation Engine (ICE)**.

The goals of the ICE project are to:

- Implement an **ICE Web Service** as a clinical module within **OpenCDS**, an open source software framework that provides developers with a robust set of resources for creating clinical decision support Web Services.
- Pre-configure ICE to provide best practice decision support for routinely administered vaccines.
- Design ICE so that it can easily integrate with a wide variety of healthcare information systems
- Create a **Clinical Decision Support (CDS) Manager** tool that enables subject matter experts to adapt and maintain immunization algorithms without the intervention of software developers.
- Freely and publicly share ICE and its source code.

3. Inputs to ICE

To utilize ICE, healthcare information systems need to send the following patient information to the **ICE Web Service**:

- Date of Birth
- Gender
- Immunization History
- Disease Indicators

4. Outputs from ICE

When the **ICE Web Service** receives the inputs, it immediately processes (but does not store) the patient information, and sends back to the healthcare information system the following decision support information for the patient:

- Evaluation of Immunization History
- Immunization Recommendations

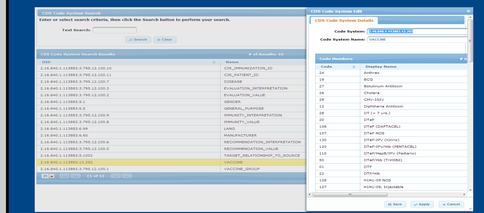
5. ICE is Pre-Configured

When it is publicly released, ICE will come pre-configured with support for the childhood, adolescent, and adult schedules for 13 vaccine groups. Users of ICE may add support for additional vaccine groups.

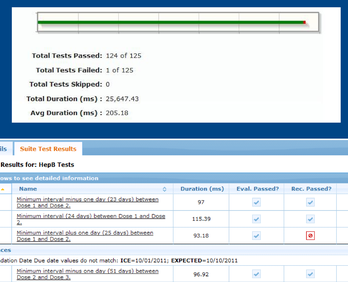
- Hepatitis B
- Rotavirus
- DTP
- Hib
- Polio
- MMR
- Varicella
- PCV Pneumococcal Conjugate
- Hepatitis A
- Meningococcal
- Human Papillomavirus
- PPSV Pneumococcal Polysacharide
- Influenza

This initial configuration of ICE is based on the recommendations of the Advisory Committee on Immunization Practices (ACIP), as interpreted by subject matter experts from the New York City Department of Health and Mental Hygiene, the Alabama Department of Public Health, and HLN Consulting, LLC.

Concept Manager

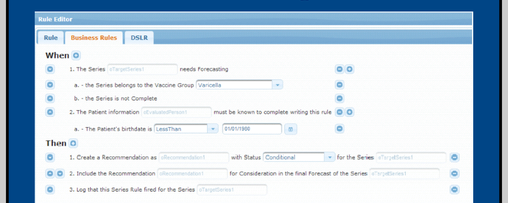


Test Manager



Schedule Manager

Rule Manager

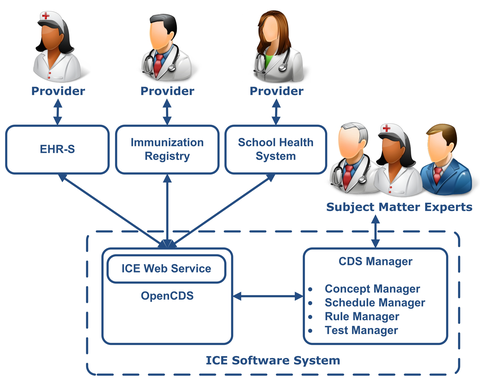


6. ICE Easily Integrates with Healthcare Information Systems

ICE is a module that can be deployed in diverse technical environments and easily integrates with third party healthcare information systems such as Electronic Health Record Systems (EHR-S), Immunization Information Systems (IIS), and Health Information Exchanges (HIEs).

- Java-based implementation enables ICE to run on a wide variety of hardware platforms, operating systems, and application servers.
- ICE may be deployed either on the same server/network as the healthcare information system that is using it or at a remote/centralized location.
- No required license fees or support fees for the ICE software system and no dependencies on any third party commercial software.
- ICE may be freely integrated and deployed with any other software system, including commercial healthcare information systems.
- Single instance of ICE can support multiple alternate schedules for use by different healthcare information systems and/or in different clinical settings.
- Web service architecture scales to process many patients simultaneously.
- Standards-based interface conforms to the Decision Support Service (DSS) standard and the Virtual Medical Record (vMR), emerging standard.

Sample ICE Deployment



7. ICE is Flexible and Adaptable

Organizations that utilize ICE can maintain and modify ICE through the use of the **Clinical Decision Support (CDS) Manager**, whose graphical user interface was designed to be used by subject matter experts who are not programmers. Organizations can utilize the CDS Manager to configure ICE to satisfy the unique requirements of a particular clinical setting, to grow as new vaccines come to market, and to adapt as the recommendations of the Advisory Committee on Immunization Practices (ACIP) change. The CDS Manager includes the following major features (*screens shown at right*):

Concept Manager – Manage vocabulary and code sets, such as vaccine names. (*see Right/Top*)

Schedule Manager – Manage basic parameters such as minimum age, minimum interval, and grace periods. (*see Right/Middle*)

Rule Manager – Manage rules that specify how immunizations are evaluated and recommended. (*see Right/Bottom*)

Test Manager – Create, store, and manage test cases. Execute hundreds of fully automated tests in seconds. Display aggregate statistics as well as detailed explanations of each failed test. (*see Far Right*)

All of the configuration data in the CDS Manager (e.g., code sets, schedule parameters, rules, and test cases) can be exported and imported at the touch of a button. This allows organizations to share configuration changes and/or deploy the same configuration to multiple instances of ICE.

8. Conclusion

The preliminary results of this project are promising and have validated the project goals. To date, six of the 13 vaccine groups have been configured and more than 500 automated tests have been created. A leading ambulatory EHR-S vendor that had no role in the development or configuration of ICE has already integrated an early version of ICE with their EHR-S product and is currently conducting alpha testing with healthcare providers who use their EHR-S. In addition, both the New York City Department of Health and Mental Hygiene and the Alabama Department of Public Health plan to integrate ICE with their immunization information systems (IIS).

When it is completed in approximately Summer 2013, the ICE software system will be publicly released as an open source software system, under the GNU Lesser General Public License v3 (LGPL v3). Implementers of Electronic Health Record Systems (EHR-S), public health agencies, Health Information Exchanges (HIEs), and other organizations in the healthcare industry will be able to deliver immunization decision support to their users by integrating this free and adaptable Immunization Calculation Engine into their healthcare information systems. Users of the ICE software system will have the freedom to reconfigure ICE through the CDS Manager and to modify the source code.

More Information about ICE and OpenCDS

For more information about ICE, visit **http://www.hln.com/ice** or send an email to **ice@hln.com**.

For more information about OpenCDS, visit **http://www.opencds.org**.

Acknowledgements

The ICE software system is being developed and configured by a collaborative partnership of physicians, public health experts, and information technology experts from the New York City Department of Health and Mental Hygiene, HLN Consulting, the Alabama Department of Public Health, and the University of Utah.