

# Improving Clinical Decision Support Systems by means of Tools and Testing

FITS

## Forecasting for Immunization Test Suite

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# Health Information Technology Tools

- Testing Frameworks & Tools
  - Improving Interoperability
  - Improving Quality

**Syndromic  
Surveillance**

**Electronic  
Lab  
Reporting**

**Public Health  
Reporting**

**Immunization**

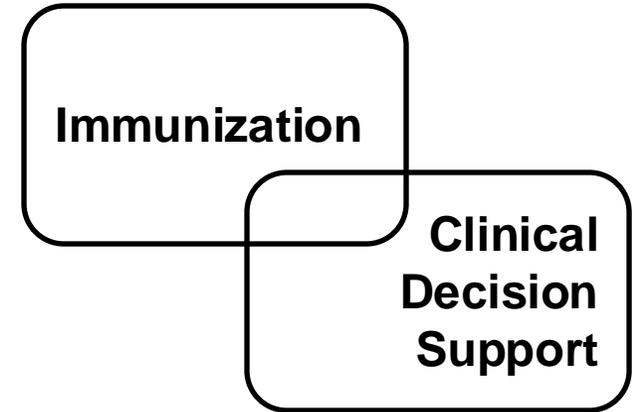
**Vital  
Records**

**Clinical  
Decision  
Support**

...

# Immunization Domain

- HL7 v2 standard testing tools
- SOAP transport testing
- Forecasting for immunization
- Data quality analysis



# What is an Immunization?

“the action of making a person or animal immune to infection, typically by inoculation.”

- Google

# Vaccination

- Best chance against viruses
- Contains weakened/altered version of a virus
- Series of shots to attain immunity

# Vaccination Forecast

- Immunity is achieved through series of shots on a set schedule
- What? and When?
  - Earliest, recommended, latest dates
- Parameters
  - Age, Gender, Contraindications, Interactions, Vaccine Type and Manufacturer

# ACIP

- Advisory Committee on Immunization Practices
  - Medical and Public Health Experts
- Published recommendations
  - CDC's Morbidity and Mortality Weekly Report
  - Epidemiology and Prevention of Vaccine-Preventable Diseases

# Vaccination Recommendations

The image displays four key components of vaccination recommendations:

- Top-Left Chart:** A schedule showing the timing of vaccine doses from birth to 17+ years. Key vaccines include Hepatitis B (HepB), Rotavirus (RV1 (2-dose series); RV5 (3-dose series)), Diphtheria, tetanus, & acellular pertussis (DTaP; <7 yrs), Influenza (IV or LAIV), Measles, mumps, rubella (MMR), Varicella (VAR), Hepatitis A (HepA), Meningococcal (MenACWY-D 1 mos; MenACWY-CRM ≥2 mos), Tetanus, diphtheria, & acellular pertussis (Tdap; ≥7 yrs), Human papillomavirus (HPV), Meningococcal B, and Pneumococcal polysaccharide.
- Top-Right Chart:** A table detailing contraindications and precautions for various vaccines. Categories include Pregnancy, Compromised (including HIV infection), CD4 count (<200, ≥200), Organ transplant, renal disease, heart or lung disease, chronic liver disease, Diabetes, Health care personnel, and Men who have sex with men.
- Middle Chart:** A detailed table of vaccine schedules. Columns include Vaccine, Minimum Age for Dose 1, Dose 1 to Dose 2, Dose 2 to Dose 3, Dose 3 to Dose 4, and Dose 4 to Dose 5. It provides specific age ranges and intervals for each vaccine.
- Bottom Chart:** A large grid of vaccine recommendations by age group (18-21 years, 22-24 years, 25-49 years, 50-64 years, 65+ years) and health status (Pregnancy, Immunocompromised status, HIV infection, Kidney failure, Heart disease, CSF leaks, Aplasia and persistent complement deficiencies, Chronic liver disease, Diabetes). The grid uses color coding to indicate recommendation status: yellow for recommended, purple for recommended with caution, and grey for no recommendation.

# Forecasting Complexity

- Multiple parameters to consider
- Multiple vaccine products for same antigen
- Constant evolution
- A lot of literature in clinical language
- Critical implications

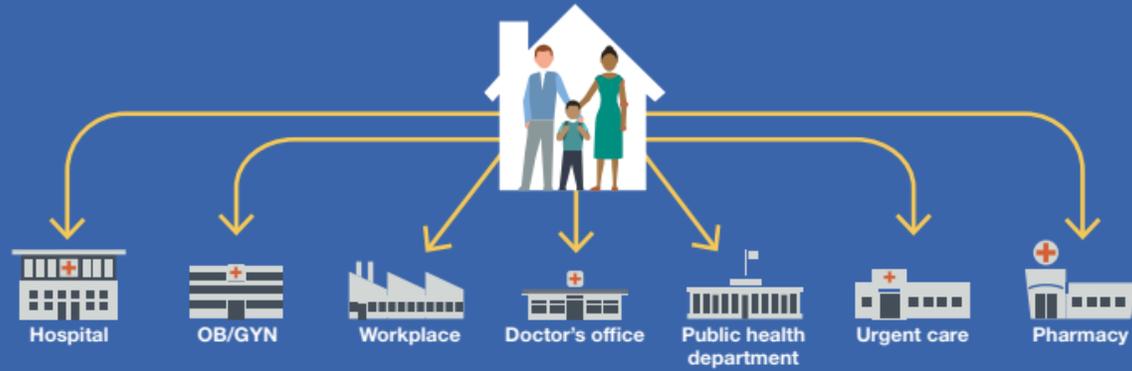
# Good News!

Well defined rules,  
can be delegated to computers

# Immunization Information System

- Confidential, population-based, computerized databases
- Store immunization doses administered by participating providers
- By Geopolitical area

## People receive vaccinations from a variety of places



## These sources send vaccination records to state or city IIS



## IISs provide records to patients and authorized professionals



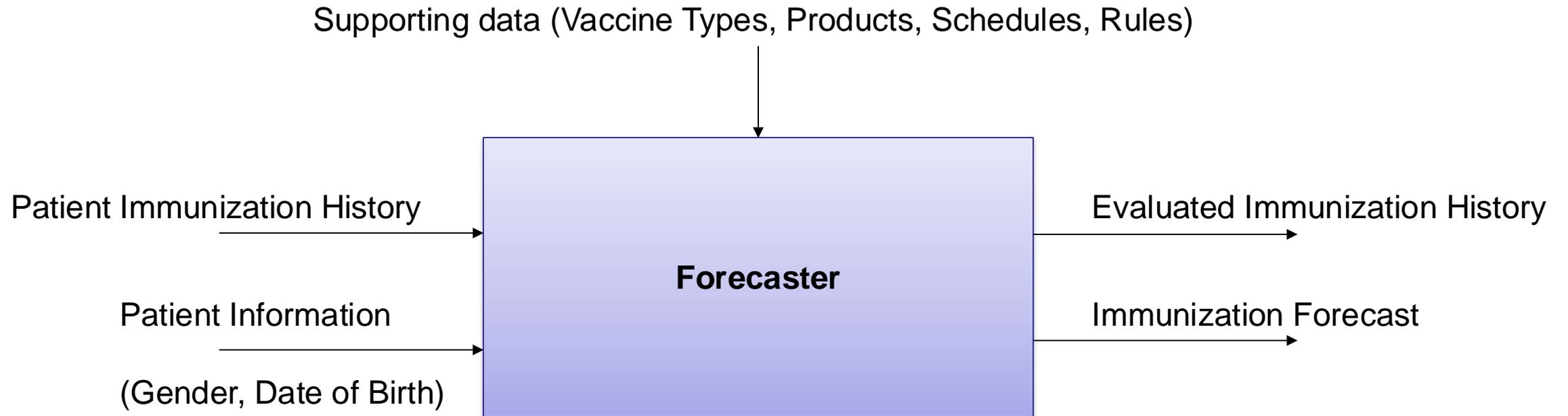
# IIS Main Roles

- Collect patient Immunization History
- Consolidate data from different sources
- Provide data to healthcare providers and Immunization programs
- Forecast immunization doses

# IIS Vaccination Forecasting

- Stores patient data necessary for forecasting
- Implements immunization forecasting rules

# IIS Vaccination Forecasting



# IIS Vaccination Forecasting Challenges

- Different software used by IIS
- Own interpretations of forecasting rules
- Sporadic updates of engines
- Managing code sets
  - Vaccine Codes
  - Product Codes

# CDSi Project

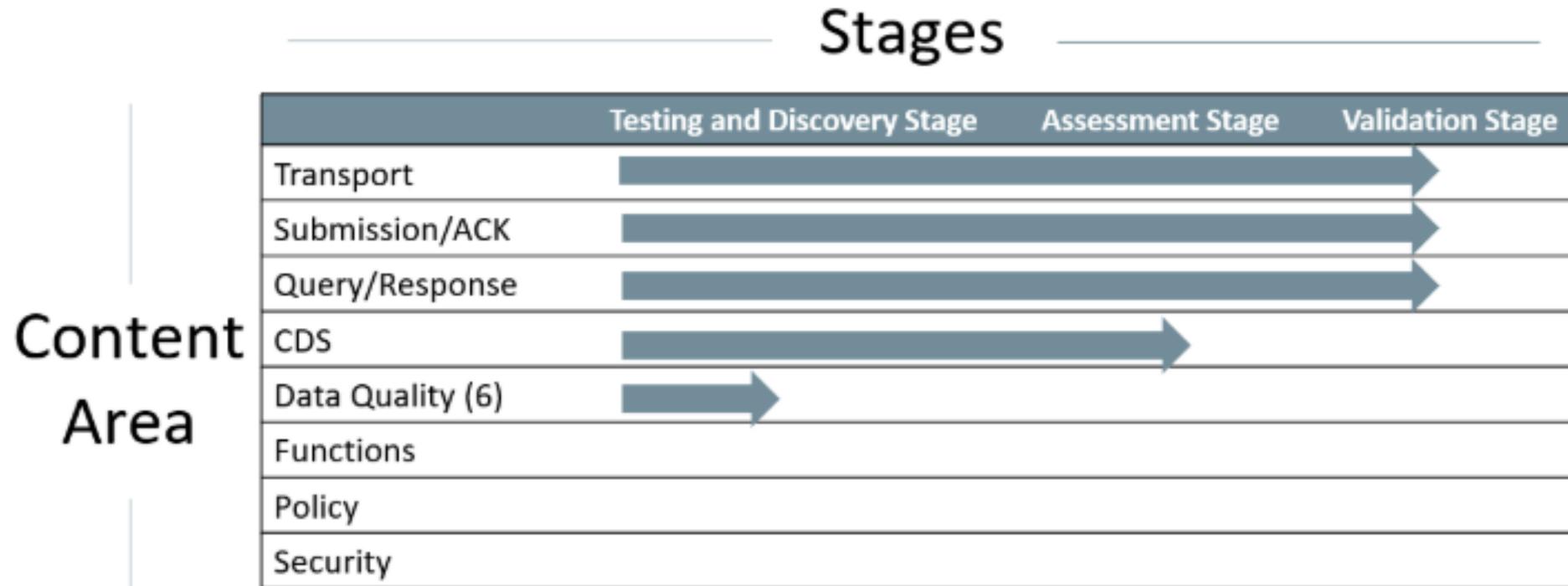
- Center of Disease Control
- Technical specification for vaccine forecasting
  - Understandable by implementers
- Supporting data in standardized format
  - Updated as ACIP recommendations change
- Test Cases for typical and edge forecasting situations

# American Immunization Registry Association

**“Promoting and supporting the use of immunization information to ensure healthy communities”**

- Tools
- Best practices
- Measurements
- Support

# AIRA's Measurement & Improvement Initiative



# Our Role

Support AIRA's mission by creating testing tools used for assessment, and to inform best practices.

# Forecasting For Immunization Testing

CDSi Test Cases use primitive tooling

59 columns  
772 rows

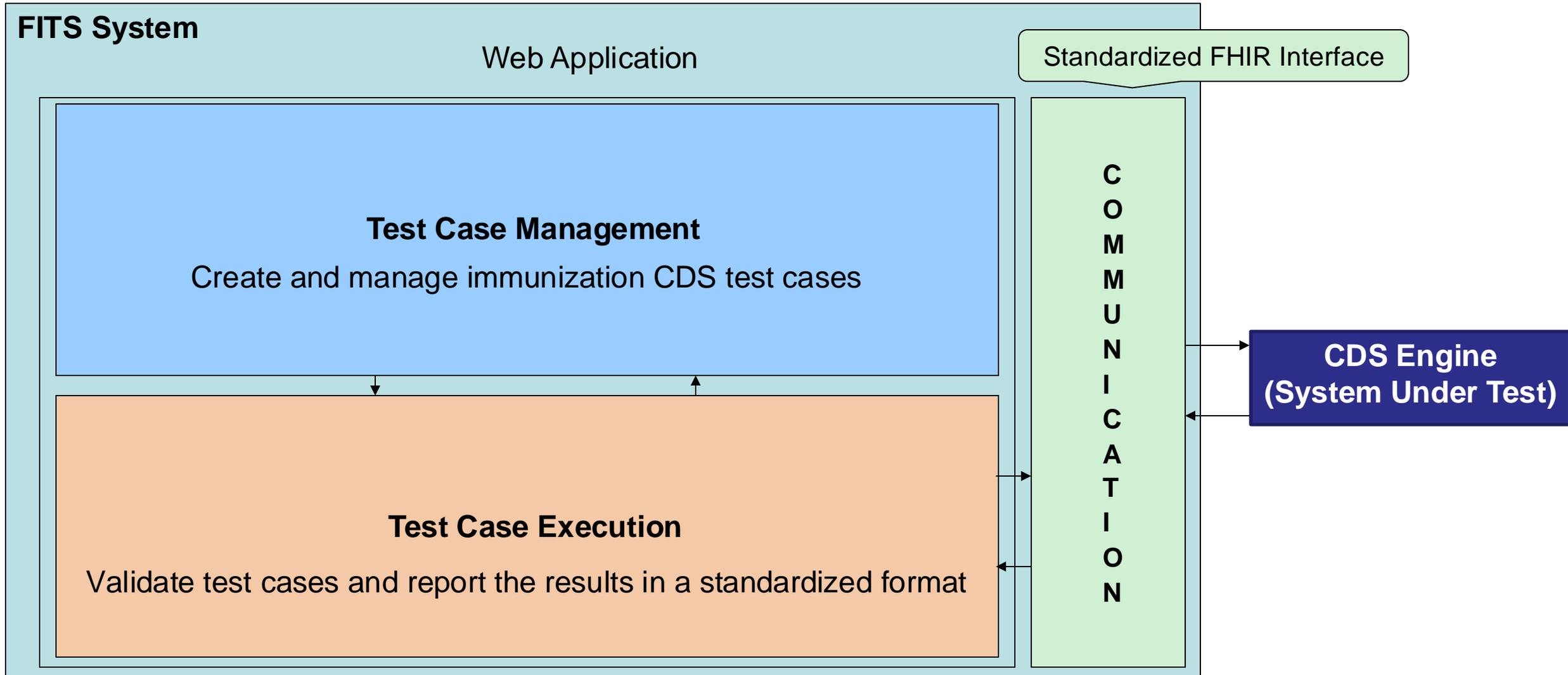
CDC_Test_ID	Test_Case_Name	DOB	gende	Med_History_Text	Med_History_Code	Med_History_Code_Sys	Series_Statu
2013-0001	Newborn Testing	02/21/2019	F				Not complet
2013-0002	DTaP #2 at age 10 weeks-5 days	12/18/2018	F				Not complet
2013-0003	DTaP #2 at 10 wks-4 days	12/17/2018	F				Not complet
2013-0004	DTaP # 2 at age 10 weeks	12/13/2018	F				Not complet
2013-0005	DTaP # 2 at age 4 months	10/21/2018	F				Not complet
2013-0007	# 2 (Tdap) to child age 7. DTaP # 1 given before age 12 months. Forecast # 3 (Td) in 4 weeks.	02/21/2012	F				Not complet
2013-0008	# 2 (Tdap) to child age 7. DTaP # 1 at ≥ 12 months. Forecast dose 3 for 6 months.	02/21/2012	F				Not complet
2013-0010	# 1 (Td) to # 2 (Tdap) interval 28-4 days in child age > 7 years. Forecast # 3 in six months.	10/25/2010	F				Not complet
2013-0011	#3 at age 14 weeks-5 days	11/20/2018	F				Not complet
2013-0012	Age 6. No vaccinations. Forecast DTaP.	02/21/2013	F				Not complet
2013-0013	#3 at age 14 weeks-4 days	11/19/2018	F				Not complet
2013-0014	#3 at age 14 weeks	11/15/2018	F				Not complet

- Time consuming
- Requires extra development to run test cases
- Error prone authoring and updates
- Forecasts expressed in fixed dates

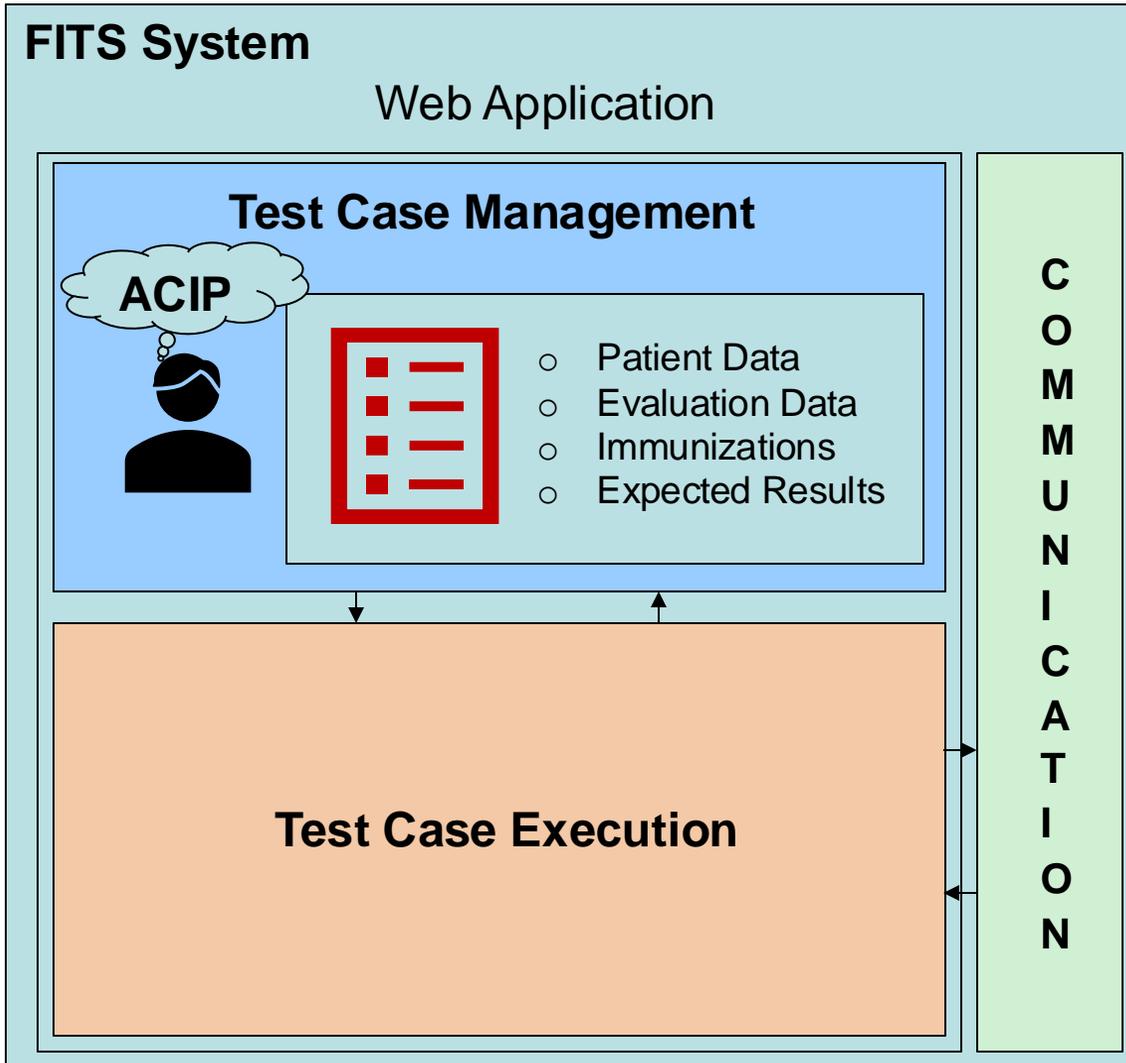
# FITS Project

- Collaboration between CDC – AIRA – NIST
- Easy authoring of forecasting test cases
- One stop shop for forecasting test cases
- Enable testing of CDS engines
  - Self testing
  - Third party testing (AIRA)

# FITS Overview

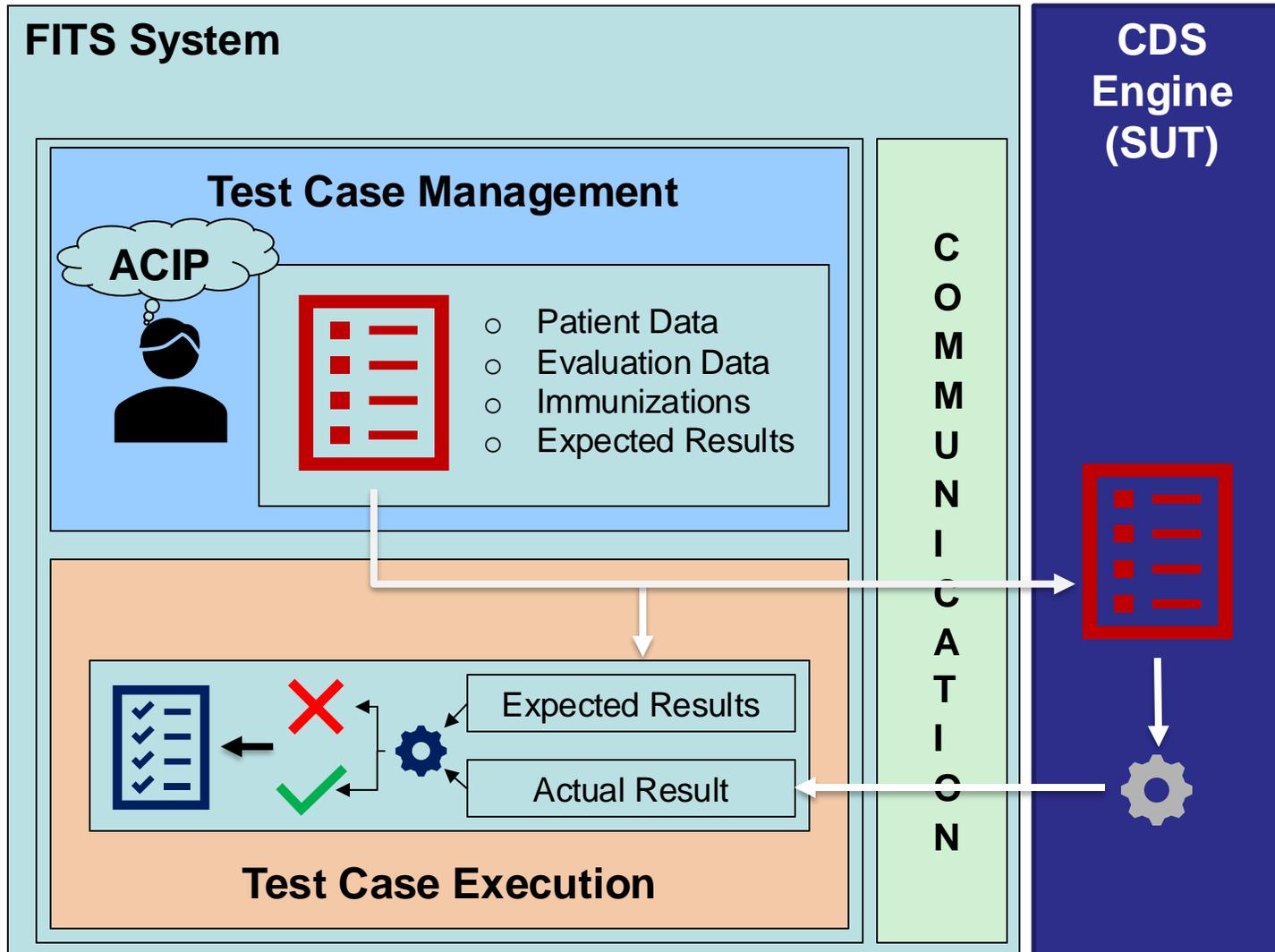


# Test Case Management



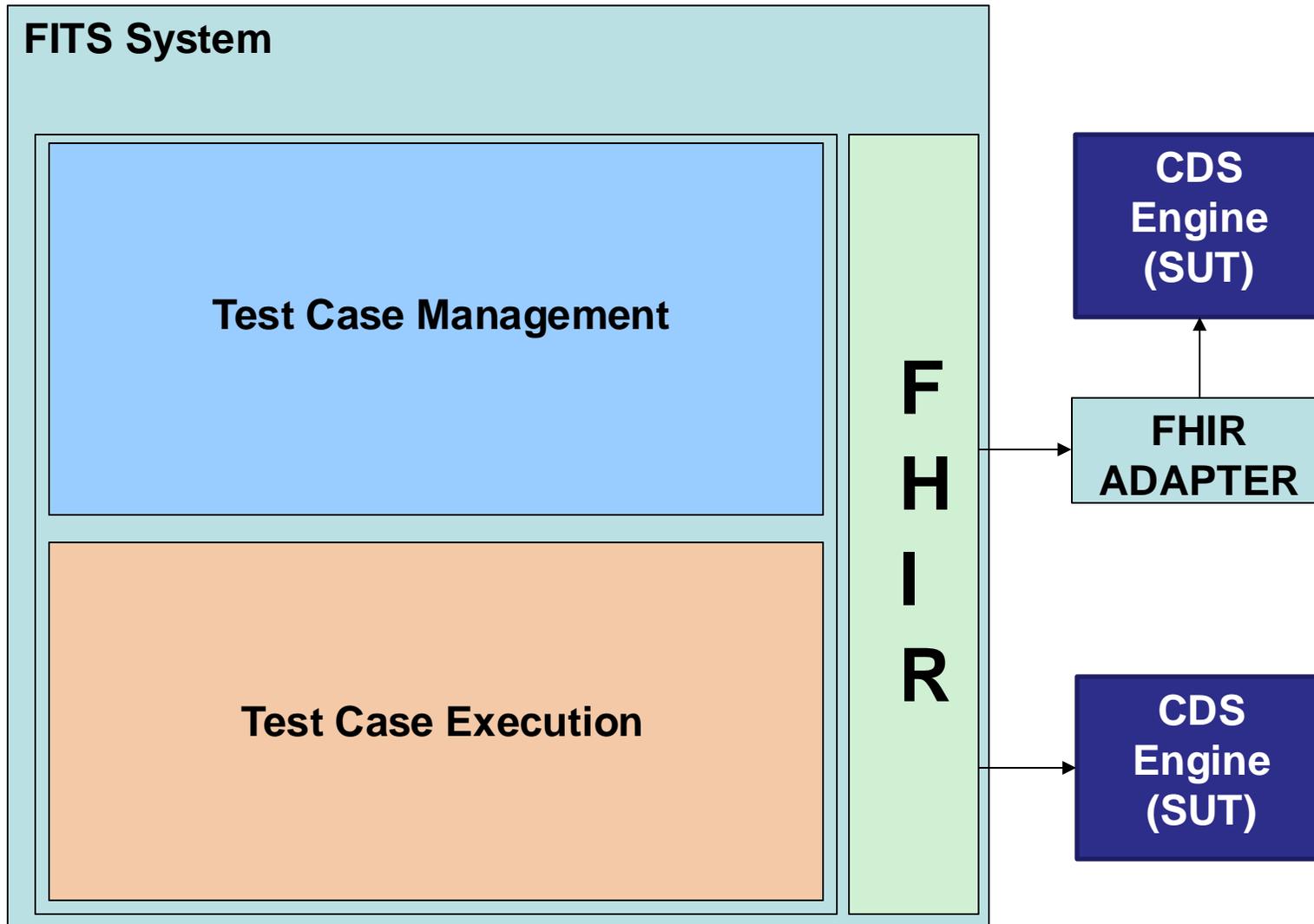
- Creating Test Plans
  - Test Case Groups (e.g. by Antigen)
- Test Cases
  - Expected Evaluation
  - Expected Earliest, Recommended (dates)
- Features
  - Organize / Tag / Lookup test cases
  - Test Cases Summary
  - Share and publish test plans
  - MVX and CVX codes lookup
  - Import from XML or Spreadsheet
  - Export to XML or Spreadsheet or PDF

# Test Case Execution



- Engine connection configuration
- Running test cases
- Engine response validation
  - Comparing response values to expected values
- Validation report
  - Export XML
  - Individual / Aggregate

# Communication



- Standardized communication
  - FHIR
  - Ballot in September
- FHIR Adapter
  - STC
  - ICE
  - SWP
  - HL7
  - Others

# Demo

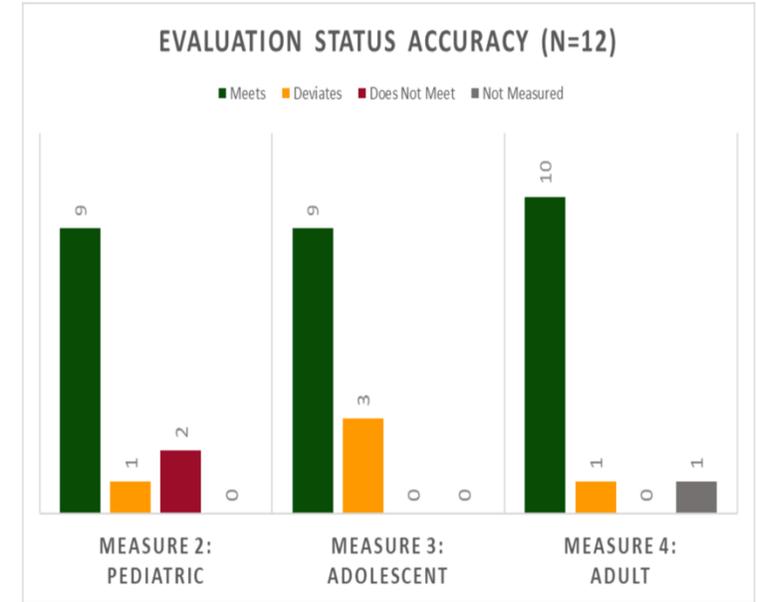
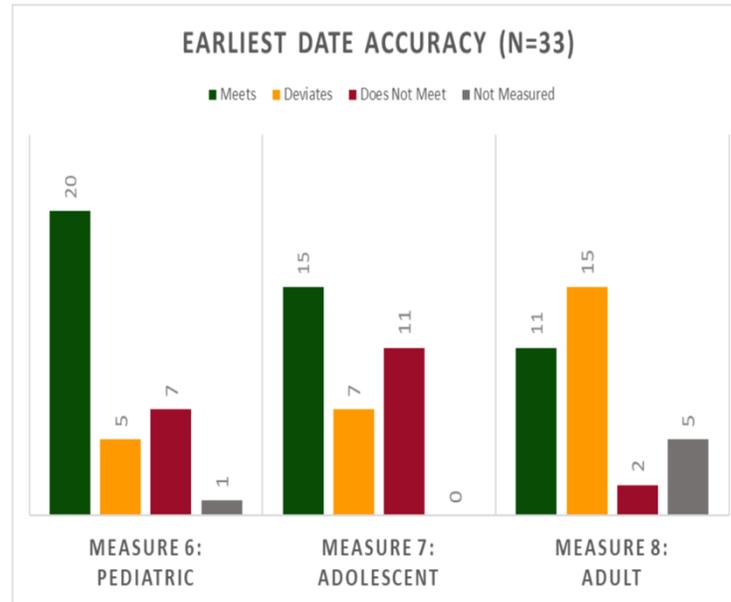
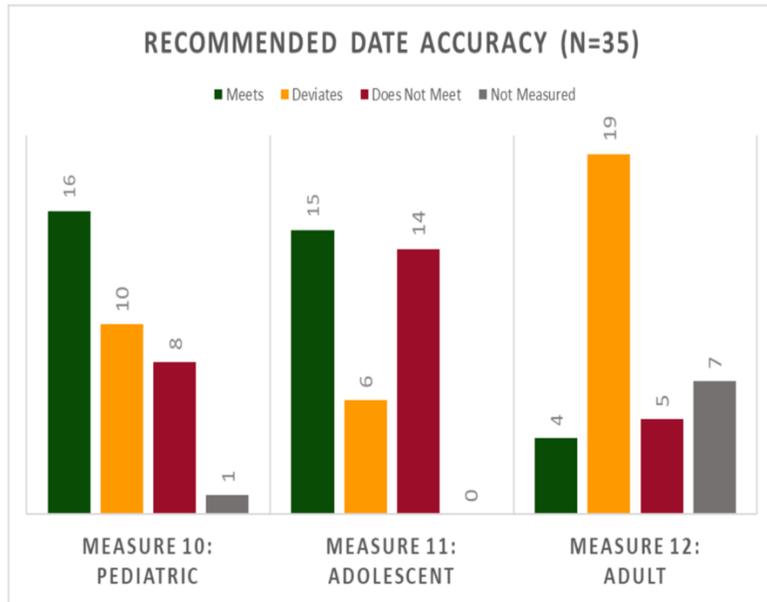
# FITS Usage

- **CDC** : CDSi project, test cases authoring and management
- **AIRA** : Assessment of IIS's Forecasting capabilities
- **USER** : Get latest published test cases, perform self testing

# Assessment Results (Support)

CDS Concept	Supports (N=35)
<b>Measure 1: Evaluation Status</b> <i>Did the dose count?</i>	<b>12</b>
<b>Measure 5: Earliest Date</b> <i>When could the next dose be given?</i>	<b>33</b>
<b>Measure 9: Recommended Date</b> <i>When should the next dose be given?</i>	<b>35</b>

# Assessment Results (Measures)

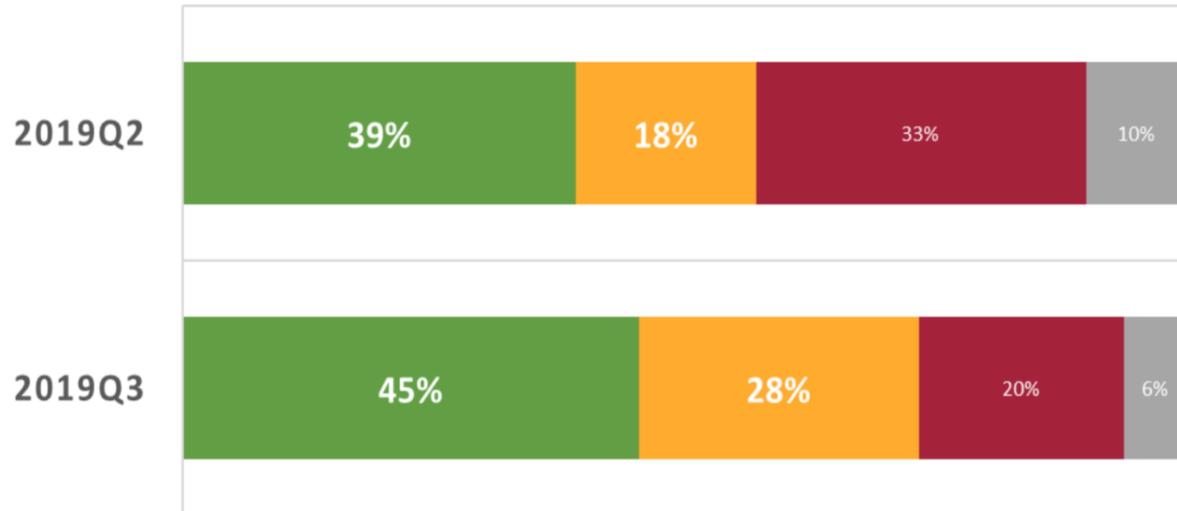


- **Meets:** The IIS has a degree of alignment score of at least 90% or more.
- **Deviates:** The IIS has a degree of alignment score of at least 65% but less than 90%.
- **Does Not Meet:** The IIS has a degree of alignment score of less than 65%.

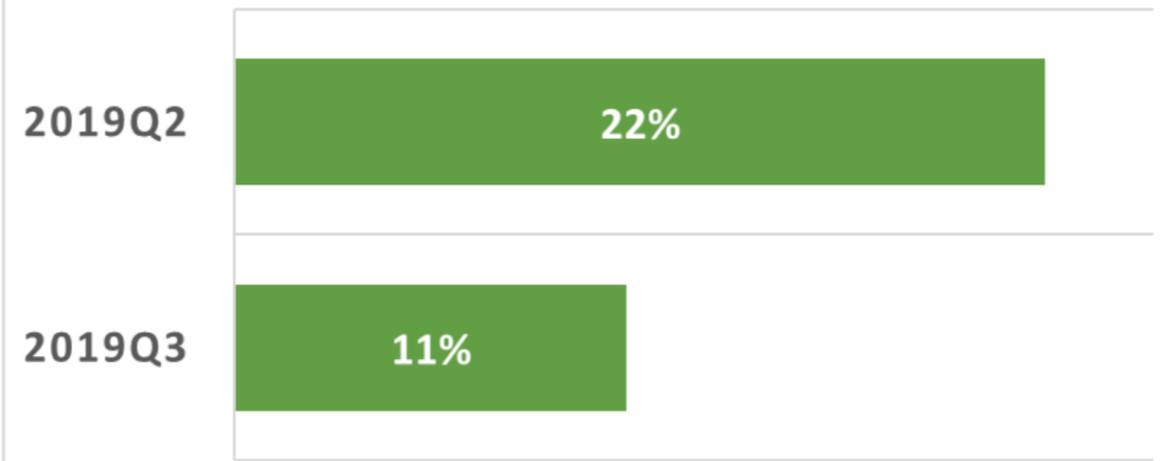
# Assessment Results (Improvement)

MEASURE OUTCOMES BY QUARTER

■ Meets ■ Deviates ■ Does Not Meet ■ Unable to Assess



PERCENT OF MEASURE OUTCOMES DOWNGRADED DUE TO VACCINE FAMILY THRESHOLD FAILURES



# Acknowledgments

- NIST Team
  - Rob Snelick – Project Manager
  - Mike Indovina – Lead Analyst
  - Andrew McCaffrey – FHIR Implementation
- AIRA Team
  - Nathan Bunker
  - Eric Larson

# Thank you!

- Tool Link:

- <https://fits.nist.gov>

- Sources:

- <https://www.cdc.gov/>

- <https://repository.immregistries.org/resource/iis-assessment-aggregate-status-report-clinical-decision-support/>

