

AIRA Education Steering Committee

Clinical Decision Support for Immunization (CDSi) 101

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National Center for Immunization & Respiratory Diseases
Immunization Information Systems Support Branch



Learning Objectives

- ❑ **What CDSi is and what CDSi isn't**
- ❑ **CDSi Artifacts**
- ❑ **Getting Started with CDSi**
- ❑ **CDSi Compliance**



What CDSi is and What CDSi isn't

CDSi isn't:

- ❑ **Creating vaccine recommendations or replacing ACIP's role**
- ❑ **Producing an application:**
 - No CDS software
 - No automated test suite
- ❑ **Replacement for current software applications**

CDSi is:

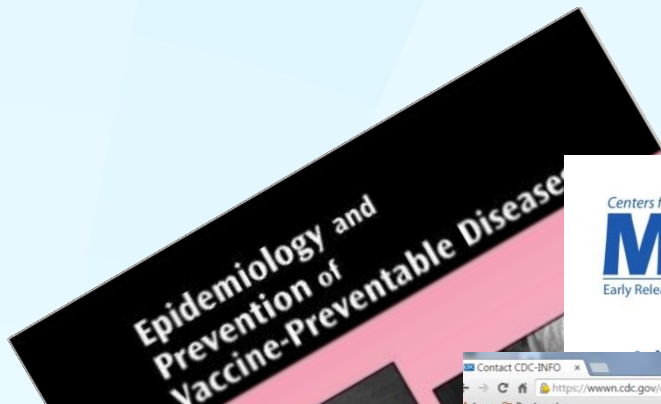
- ❑ **A bridge between ACIP recommendations and IIS/EHRs:**
 - Documentation of logic and supporting data
 - Formalized communication mechanism and process
- ❑ **Providing guidance for groups who want to implement the panel's deliverables**
- ❑ **Establishing a communication mechanism between immunization community and ACIP**

Translating ACIP Recommendations



- ❑ Translation of scientific language to technical logic is complex and time-consuming
- ❑ Uniform interpretation is challenging:
 - Mostly happened independently within each health information system
 - Significant variance in system outputs
 - Outputs frequently didn't match expectations of clinical SMEs

Sources of Knowledge



Centers for Disease Control and Prevention
MMWR
Early Release / Vol. 62

FIGURE 1. Recommended immunization schedule for persons aged 0 through 6 years — United States, 2009
Persons who fall behind or start late, see the catch-up schedule [Table]

These recommendations must be read with the footnotes that follow. For those who fall behind or to determine minimum intervals between doses, see the catch-up schedule (Figure 2). School entry

Vaccines	Birth	1 mo	2 mos	4 mos	6 mos	9 mos
Hepatitis B ¹ (HepB)	1 st dose	2 nd dose				
Rotavirus ² (RV) RV1 (2-dose series); RV2 (3-dose series)		1 st dose	2 nd dose	See footnote 2		
Diphtheria, tetanus, & acellular pertussis ³ (DTaP- <7 yrs)		1 st dose	2 nd dose	3 rd dose		
Tetanus, diphtheria, & acellular pertussis ³ (Tdap- ≥ 7 yrs)			1 st dose	2 nd dose	See footnote 5	
Haemophilus influenzae type b ⁴ (Hib)		1 st dose	2 nd dose	3 rd dose		
Pneumococcal conjugate ⁵ (PCV13)		1 st dose	2 nd dose	3 rd dose		
Pneumococcal polysaccharide ⁶ (PPSV23)						
Inactivated Poliovirus ⁷ (IPV) (<18 yrs)		1 st dose	2 nd dose			
Influenza ⁸ (IV:IAV) 2 doses for some: See footnote 8						
Measles, mumps, rubella ⁹ (MMR)						
Varicella ¹⁰ (VAR)						
Hepatitis A ¹¹ (HepA)						
Human papillomavirus ¹² (HPV2: females only; HPV4: males and females)						
Meningococcal ¹³ (Men-CY ≥ 6 weeks; MenACWY-D ≥ 9 mos; MenACWY-CRM ≥ 2 mos)						See footnote 13

Range of recommended ages for all children Range of recommended ages for catch-up immunization Range of ages for groups

This schedule includes recommendations in effect as of January 1, 2014. Any dose not administered at the vaccine generally is preferred over separate injections of its equivalent component vaccines. Vaccination on recommendations, available online at <http://www.cdc.gov/vaccines/imz/byz/index.html>. Clinically sig (VAERS) online (<http://www.vaers.hhs.gov>) or by telephone (800-822-7967). Suspected cases of vaccine-pre precautions and contraindications for vaccination, is available from CDC online (<http://www.cdc.gov/vaccin>). This schedule is approved by the Advisory Committee on Immunization Practices (<http://www.cdc.gov/nacw>), the American College of Obstetricians and Gynecologists (<http://www.acog.org>).

NOTE: The above recommendations must be read along with the footnotes of t

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NOTE: Many CDC publications are available to download, view online, or order at no cost.

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Range of recommended ages
Certain high-risk groups

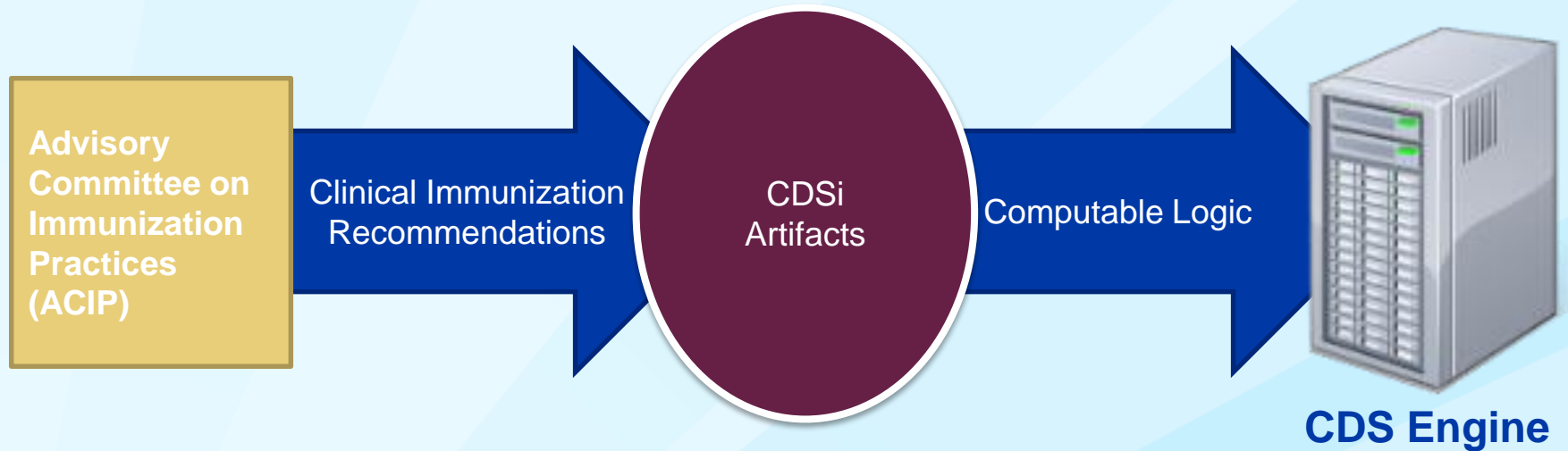
DTaP
PPSV
IPV
MMR
Varicella
HPV Series
MCV

States, 2009
years
dap
Series
MCV

Range of recommended ages
Catch-up immunization
Certain high-risk groups

Varicella¹⁰

Bridging the Gap



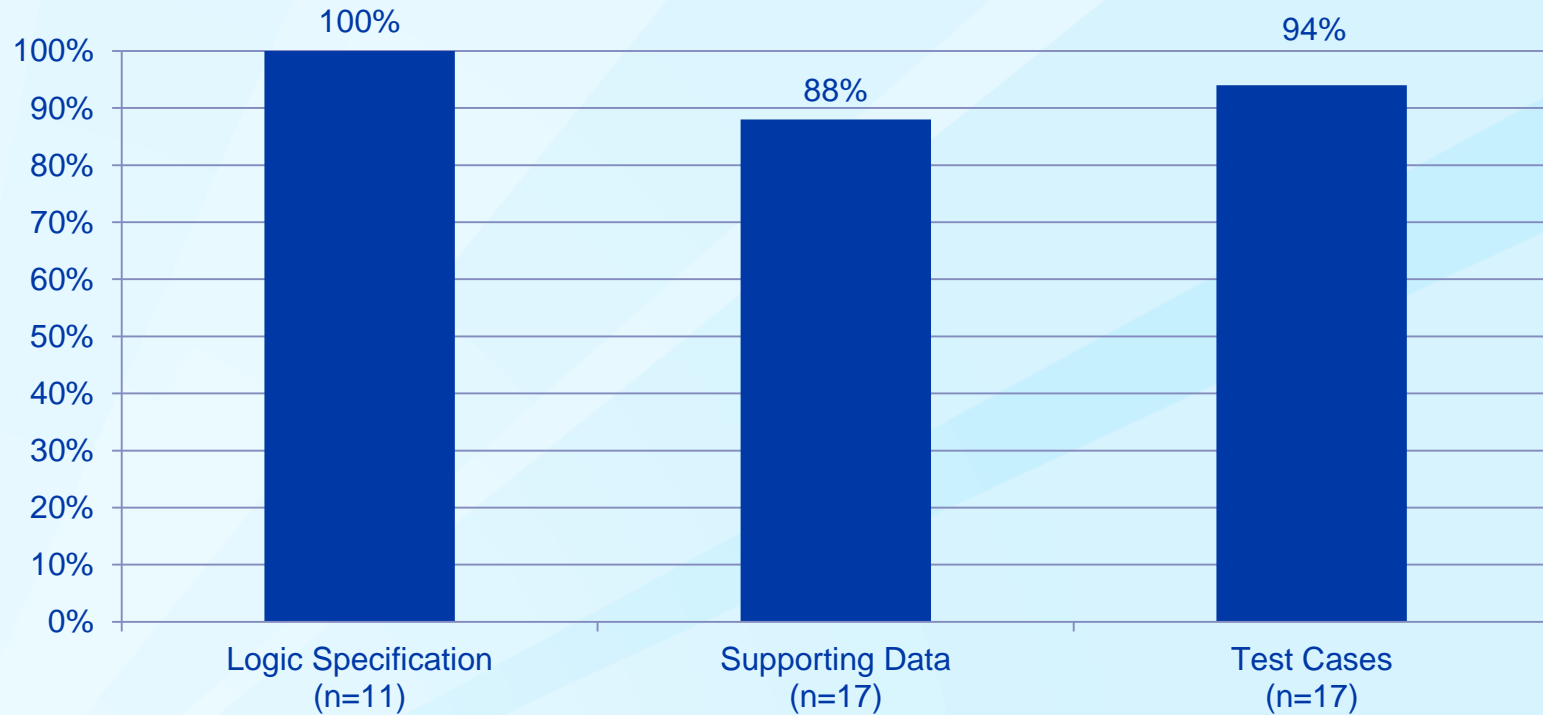
- ❑ Increase the accuracy and consistency of immunization evaluation and forecasting
- ❑ Improve the process of accommodating new and/or changed ACIP recommendations
- ❑ Make it easier to develop and maintain immunization evaluation and forecasting products
- ❑ Ensure patients get “the right immunization at the right time”

Project Phases

	Phase 1	Phase 2	Phase 3
Foundation	Current ACIP Recommendations		
Scope	Healthy children, birth through 18 years	Healthy people, birth to death	Birth to death, with: <ul style="list-style-type: none"> • Precautions • Special indications • High, increased, or special risks • Travel
Resources Created	<ul style="list-style-type: none"> • Logic Specification • Supporting Data • Test Cases 	<ul style="list-style-type: none"> • Logic Specification • Supporting Data • Test Cases 	<ul style="list-style-type: none"> • Logic Specification • Supporting Data • Test Cases • Code Set for Precautions, Special Indications, etc.
Publication Date	November 2013	June 2015	Estimated: first half of 2016

Business Rules in CDSi

Of those who have used the CDSi resources,
do you plan to use them in the future?



ACIP Age Recommendations on Varicella

TABLE 1. Recommended and minimum ages and intervals between vaccine doses*†

Vaccine and dose number	Recommended age for this dose	Minimum age for this dose
Varicella-1†††	12—15 months	12 months
Varicella-2†††	4—6 years	15 months

Vaccine ▼	Age ►	Birth	1 month	2 months	4 months	6 months	9 months	12 months	15 months	18 months	19–23 months	2–3 years	4–6 years
Varicella ⁹								Varicella			see footnote ⁹		Varicella

9. Varicella (VAR) vaccine. (Minimum age: 12 months)

- The second dose may be administered before age 4 years, provided at least 3 months have elapsed since the first dose.
- For children aged 12 months through 12 years, the recommended minimum interval between doses is 3 months. However, if the second dose was administered at least 4 weeks after the first dose, it can be accepted as valid.

Doses administered too close together or at too young an age can lead to a suboptimal immune response. However, administering a dose a few days earlier the minimum interval or age is unlikely to have a substantially negative effect on the immune response to that dose. Vaccine doses administered ≤ 4 days before the minimum interval or age are considered valid.

<http://www.cdc.gov/mmwr/pdf/rr/rr6002.pdf>

<http://www.cdc.gov/vaccines/schedules/downloads/child/0-18yrs-11x17-fold-pr.pdf>

Structured Age Representation of Varicella

Dose #	Absolute Min Age	Min Age	Earliest Recommended Age	Latest Recommended Age (less than)	Max Age (less than)
1	12m – 4d	12m	12m	16m + 4w	n/a
2	12m + 4w	15m	4y	7y + 4w	n/a

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Dose #	Absolute Min Age	Min Age	Earliest Recommended Age	Latest Recommended Age (less than)	Max Age (less than)
1	12m – 4d	12m	12m	16m + 4w	n/a
2	12m + 4w	15m	4y	7y + 4w	n/a

More Structured Age Representations

Series	Dose #	Absolute Minimum Age	Minimum Age	Earliest Recommended Age	Latest Recommended Age (less than)	Maximum Age (less than)
HepA	1	12m – 4d	12m	12m	24m +4w	n/a
Rotavirus	2	10w – 4d	10w	4m	5m + 4w	8m + 1d
MCV	1	2y – 4d	2y	11y	13y + 4w	n/a

<http://www.cdc.gov/mmwr/pdf/rr/rr6002.pdf>

<http://www.cdc.gov/vaccines/schedules/downloads/child/0-18yrs-11x17-fold-pr.pdf>

Supporting Data

Series Dose	Dose 2					
Age	Absolute Minimum Age	Minimum Age	Earliest Recommended Age	Latest Recommended Age (less than)	Maximum Age (less than)	
	12 Months + 4 weeks	15 Months	4 years	7 years + 4 weeks	n/a	
Interval	From Immediate Previous Dose Administered: Y/N	From Target Dose # in Series	Absolute Minimum Interval	Minimum Interval	Earliest Recommended Interval	Latest Recommended Interval (less than)
	Y	n/a	12 weeks - 4 days	12 weeks	3 years	6 years + 4 weeks
Allowable Interval	From Immediate Previous Dose Administered: Y/N	From Target Dose # in Series	Absolute Minimum Interval			
	Y	n/a	4 weeks			
Preferable Vaccine	Vaccine Type (CVX)	Vaccine Type Begin Age	Vaccine Type End Age (less than)	Trade Name (MIX)	Volume (in ml)	
	Varicella (21)	12 Months	n/a	n/a	0.5	
	MMRV (94)	12 Months	13 Years	n/a	0.5	
Allowable Vaccine	Vaccine Type (CVX)	Vaccine Type Begin Age	Vaccine Type End Age (less than)			
	Varicella (21)	12 Months - 4 days	n/a			
	MMRV (94)	12 Months - 4 days	n/a			
	Zoster (121)	12 Months - 4 days	n/a			
Skip Dose	Triquet Age	Triquet Interval	Triquet Target Dose	Triquet Doses Administered		
	n/a	n/a	n/a	n/a		
Recurring Dose	Recurring Dose (Year/No)					
	No					
Conditional Need	Condition Set	Start Date	End Date	Dose Count (less than)	CVX List	
	n/a					
Seasonal Recommendation	Start Date	End Date				
	n/a					
Substitute Dose	total count of valid doses	First Dose Begin Age	First Dose End Age (less than)	number of target doses to substitute		
	n/a					
Gender	Required Gender					
	n/a					

Logic Specification Documentation Techniques

Domain Model, Vocabulary, and Glossary

- ❑ Used to drive consistency, understanding of terms, and relationship between terms

Decision Tables

- ❑ Used to convey conditional logic and outcomes

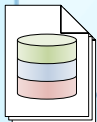
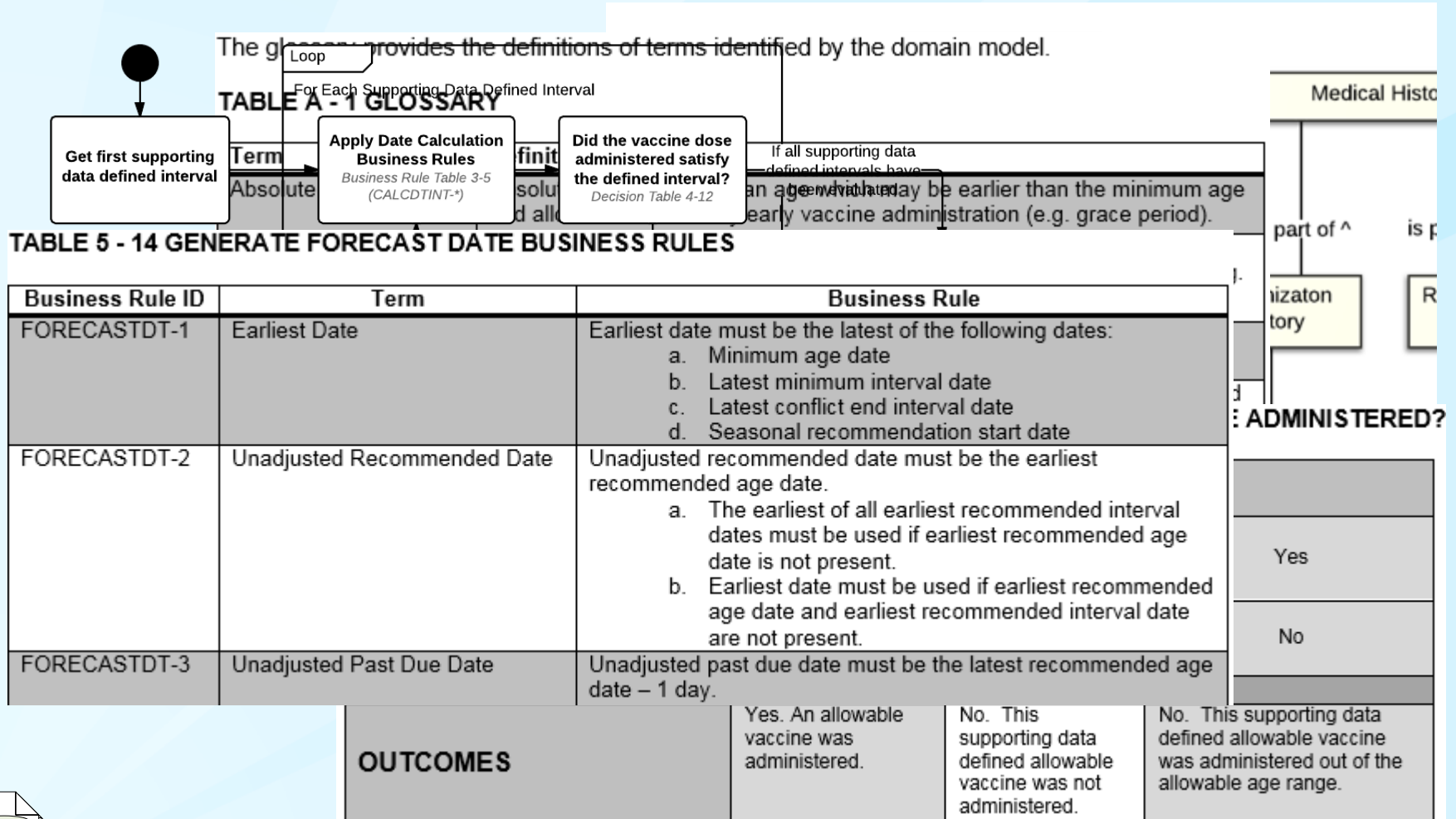
Business Rules

- ❑ Used to express data calculations and declarative rules.

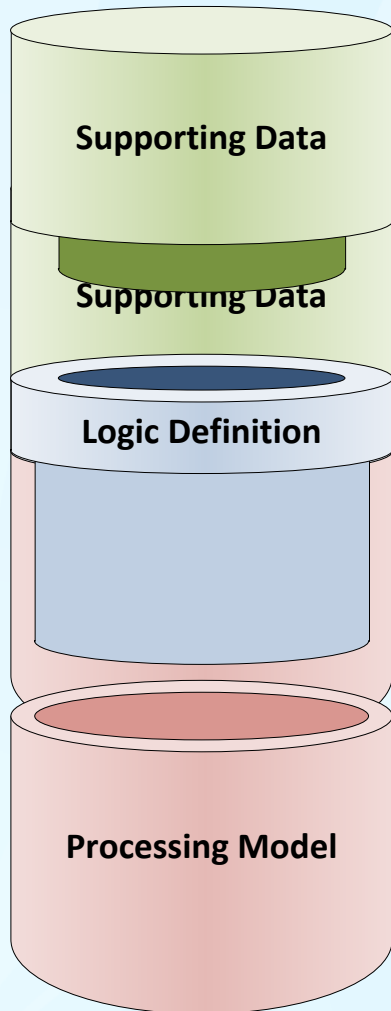
Process Models

- ❑ Used to chain decisions and/or business rules together.

Logic Specification Samples



Logic Specification Components

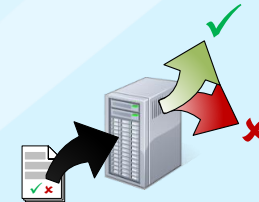


- ❑ **Abstracted attributes and values**
 - Standard data table definitions
 - Antigen specific values
 - Static definitions
 - Dynamic values
- ❑ **Functionality for evaluation/forecasting**
 - Thin process models
 - Decision tables
 - Business rules
 - Static
- ❑ **Processing Model**
 - Activity diagrams
 - Static

Dynamic vs. Static



Test Cases



□ **GOAL:**

- Create a representative set of consensus-based systematic test cases that can be used by an immunization evaluation and forecasting engine

□ **~765 Test Cases**

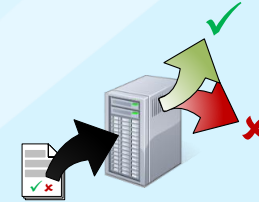
□ **Published in an Excel spreadsheet for easy usage**

□ **Each Test Case:**

- Focuses on one unique problem (e.g.: minimum age only)
- Provides the answer (e.g.: expected outcome; usually a forecast)
- Is classified by vaccine group, evaluation test type, and forecast test type

Test Case Sample

Hib – Dose #2 at 10 weeks – 5 days



❑ Test Case Scenario


Birth Date	01/01/2010
Dose #1	Admin: 02/08/2010 Age: 5 weeks 3 days ACTHIB
Dose #2	03/07/2010 Age: 9 weeks 2 days ACTHIB

❑ CDSi Expected Result

Birth Date	01/01/2010
Dose #1	Eval Status: Valid
Dose #2	Eval Status: Not Valid Reason: Age too young
Forecast	Earliest Date: 04/04/2010 Rec Date: 05/01/10 Latest Date: 6/28/10

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Clinical Decision Support for Immunization (CDSi)




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CDSi: Clarity, Consistency, and Computability

Immunization clinical decision support (CDS), more commonly referred to as evaluation and forecasting, is an automated process that determines the recommended immunizations needed for a patient and delivers these recommendations to the healthcare provider. Health Information Systems (HIS) – which can include Health Information Exchanges (HIEs), Immunization Information Systems (IIS)

On this Page

- Logic Specification and Supporting Data
- Testing
- Training
- Support
- Additional Resources
- Project Background

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National Center for Immunization and Respiratory Diseases
Centers for Disease

Using CDSi Resources

From minor to major engagement

- ❑ **Research specific ACIP Recommendation**
 - < 1 hour: Individual research or supported by CDSi project team
- ❑ **Take training courses**
 - < 1 hour: per course
- ❑ **Execute and compare the test cases expected results against CDS engine's actual results**
 - < 1 day: Manually execute a handful of test cases
 - < 1 month: Automate all test cases
- ❑ **Compare CDSi supporting data against CDS engine's supporting data**
 - < 1 week: Per vaccine group
- ❑ **Develop/Improve CDS engine logic based on CDSi Logic Specification**
 - Really depends on scope of development and improvement

CDSi Alignment

❑ CDSi Status Check

- 38 participants
- Each Participant received an individualized report
- Aggregate data showed better alignment for users of CDSi
- Limitation: 12 test cases
- Limitation: All tests were edge cases
 - e.g., day before valid, day of valid dose, etc.

❑ Test Cases

- Community vetted
- Updated with new/changed ACIP recommendations
- Limitation: Self-Assessment
- Limitation: Representative sample

CDSi Compliance

- ❑ **No formal or official CDC compliance testing exists.**
- ❑ **CDC in very early stages of exploring what – if anything – can be done.**

Questions

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CDC Program Management

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**Northrop Grumman Corporation
Sr. Informatics Specialist**

<http://www.cdc.gov/vaccines/programs/iis/interop-proj/cds.html>

Or simply Google “CDC CDSi”

**For more information please contact Centers for Disease Control and
Prevention**

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