Enhancing HPV/Tdap Schedule Forecasting Accuracy: Success in Aggregate Analysis Reporting Tool (AART) Validation

Vijaya Icchapurapu, Epidemiologist III,
Texas DSHS Immunization Information Systems (IIS) Unit

Agenda

- Introduction
- Background and importance of schedules and forecasting
- Components of effective Immunization Schedules
- Data-driven approaches to optimization
- Challenges
- Future direction to immunization optimization

TEXAS Health and Human Services

Texas Department of State Health Services

Introduction

- Objective:
  - Improve the accuracy of immunization forecasting within Texas Immunization Information Systems (IIS).
- Key Goals:
  - To meet the standards for accurate vaccine forecasting established by Center for Disease Control (CDC) and Advisory committee on Immunization Practices (ACIP).
  - Meet validation standards of American Immunization Registry Association (AIRA).
  - Increase Human Papilloma Virus (HPV) and Tetanus Diphtheria and Pertussis (Tdap) coverage rates among adolescents.

Background

Objective of IIS Functionality Standards

- Setting standards that the IIS establishes and maintains Clinical Decision Support (CDS) functionality to ensure accurate, reliable schedules.
- Guide healthcare providers for appropriate clinical decisions.

Impact

- Reduces missed vaccination opportunities.
- Increases adherence to vaccination timelines.
- Improves immunization coverage rates in children and adolescents.

Problem

- HPV and Tdap did not meet basic validation standards, resulting in inaccurate forecasting.

Evaluation and Forecasting

What is evaluation and forecasting?

Immunization CDS is also known as evaluation and forecasting.

It is based on guidelines and recommendations from the ACIP.

The process involves translating clinical language into technical logic commonly referred to as immunization schedules.

Why is it important?

The goal is to determine vaccine administration based on age and time intervals.

These timelines help build immunity against deadly communicable diseases.

CDS benefits children, adolescents, and adults by ensuring timely vaccinations.

ACIP Guidelines

- HPV Dosage Guidelines:
  - HPV vaccination routinely recommended at age 11–12 years (can start at age 9 years)
  - 2- or 3-dose series depending on age at initial vaccination:
    - Age 9 –14 years at initial vaccination:
      - 2-dose series at 0, 6–12 months (minimum interval: 5 months;
      - repeat dose if administered too soon)
    - Age 15 years or older at initial vaccination:
      - 3-dose series at 0, 1–2 months, 6 months (minimum intervals: dose 1 to dose 2 = 4 weeks; dose 2 to dose 3 = 12 weeks; dose 1 to dose 3 = 5 months;
      - repeat dose if administered too soon)

ACIP Guidelines

- Tdap Dosage Guidelines:
  - Routine vaccination:
    - Age 11–12 years: 1 dose Tdap (adolescent booster)
  - Catch-up vaccination:
    - Age 13–18 years who have not received Tdap: 1 dose Tdap (adolescent booster)
    - Age 7–18 years not fully vaccinated*with DTaP: 1 dose Tdap as part of the catch-up series (preferably the first dose); if additional doses are needed, use Td or Tdap.
    - Tdap administered at age 7–10 years:
    - Age 7–9 years who receive Tdap should receive the adolescent Tdap booster dose at age 11–12 years.
    - Age 10 years who receive Tdap do not need the adolescent Tdap booster dose at age 11–12 years.
  - Note: Tdap may be administered regardless of the interval since the last tetanus- and diphtheria-toxoid-containing vaccine.

The Problem

Texas IIS HPV and Tdap schedules consistently failed to meet AIRA validation standards.

HPV forecasting Issues: Only 53% of cases met the minimum validation threshold of 65%.

Tdap: Less than 60% of cases met the validation standards set by AIRA.

Incorrect forecasting leading to missed opportunities, failure to adhere to CDC’s Advisory Committee on Immunization Practices (ACIP) guidelines.

HPV Schedule

2013-0440 #2 with interval of 4 weeks from #1

Conforms Status	Does Not Meet
Test Run Status	Finished
Evaluation Date	02/16/2023
Birth Date	01/19/2012
FITS Group Name	HPV
Measure Type	Accuracy
Measure Criterion	ED

Evaluations

Date	Vaccine	Expected	Actual	FITS Status
01/19/2023	HPV, unspecified formulation (137)	VALID	VALID	Pass
02/16/2023	HPV, unspecified formulation (137)	VALID	VALID	Pass

Forecasts

HPV, unspecified formulation (137)	Expected	Actual	FITS Status
Series Status	Not complete		Unknown
Earliest Date	06/19/2023	-	Unknown
Recommended Date	07/19/2023	-	Unknown
Past Due Date	03/17/2024	-	Unknown

- 2nd HPV dose given before the recommended 5-month interval will need an additional dose forecasted.
- To correct this required the addition of an early dose schedule to validate and forecast appropriately.

Add New Imms | Add Historical Imms | Edit Client | Reports | Print Official

Immunization Record — Tracking Schedule: ACIP

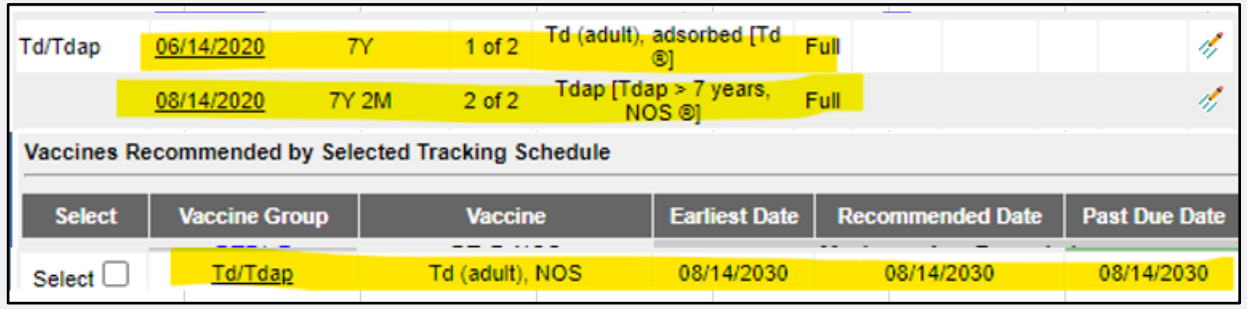
Vaccine Group	Date Admin	Age At Immunization	Series	Vaccine [Trade Name]	Dose	Owned?	Re
HPV	02/01/2018	11Y 1M	1 of 2	HPV4 [Gardasil 4 ®]	Full		
	03/03/2018	11Y 2M	2 of 2	HPV4 [Gardasil 4 ®]	Full		

Vaccines Recommended by Selected Tracking Schedule

Select	Vaccine Group	Vaccine	Earliest Date	Recommended Da
Select ☐	HepA	HepA, NOS	01/01/2008	01/01/2008
Select ☐	HepB	HepB, NOS	01/01/2007	01/01/2007
	HPV	HPV, NOS		Complete

Tdap Schedule

- Tdap/Td vaccine received at 7 years of age schedule is expected to forecast for a booster dose at 11 years of age.
- System was forecasting 5 years from the last dose. Scheduler was triggered by interval logic instead age logic



Td/Tdap	06/14/2020	7Y	1 of 2	Td (adult), adsorbed [Td ®]	Full
	08/14/2020	7Y 2M	2 of 2	Tdap [Tdap > 7 years, NOS ®]	Full

Vaccines Recommended by Selected Tracking Schedule

Select	Vaccine Group	Vaccine	Earliest Date	Recommended Date	Past Due Date
Select ☐	Td/Tdap	Td (adult), NOS	08/14/2030	08/14/2030	08/14/2030

2013-0017 Doses # 2 and # 3 at ≥7 years old; dose # 1 at ≥ 12 months old.

Conforms Status	Does Not Meet
Test Run Status	Finished
Evaluation Date	02/22/2024
Birth Date	05/03/2016
FITS Group Name	DTAP
Measure Type	Accuracy
Measure Criterion	ED

Evaluations

Date	Vaccine	Expected	Actual	FITS Status
07/05/2017	DTaP, unspecified formulation (107)	VALID	VALID	Pass
05/11/2023	Td (adult), 2 Lf tetanus toxoid, preservative free, adsorbed (09)	VALID	VALID	Pass
02/22/2024	Tdap (115)	VALID	VALID	Pass

Forecasts

DTaP, unspecified formulation (107)	Expected	Actual	FITS Status
Series Status	Not complete		Unknown
Earliest Date	05/03/2027	02/22/2029	Fail
Recommended Date	05/03/2027	02/22/2029	Fail
Past Due Date	05/30/2029	-	Unknown

Solution

Additional Schedules: Introduced to complement the existing ones and improve forecasting.

Backend Updates: Vendor support to update logic to meet age and interval guidelines from the Clinical Decision Support (CDS) document.

Validation Testing: AART validation standards were the benchmark for success.

Results

Immunization Record Tracking Schedule ACIP

Vaccine Group	Date Admin	Age At Immunization	Series	Vaccine [Trade Name]	Dose	Owned?	Reaction	Hist?	Disaster	Edit
HPV	10/25/2022	11Y	1 of 3	HPV, NOS [HPV, NOS ®]	Full					
	11/28/2022	11Y 1M	2 of 3	HPV, NOS [HPV, NOS ®]	Full					

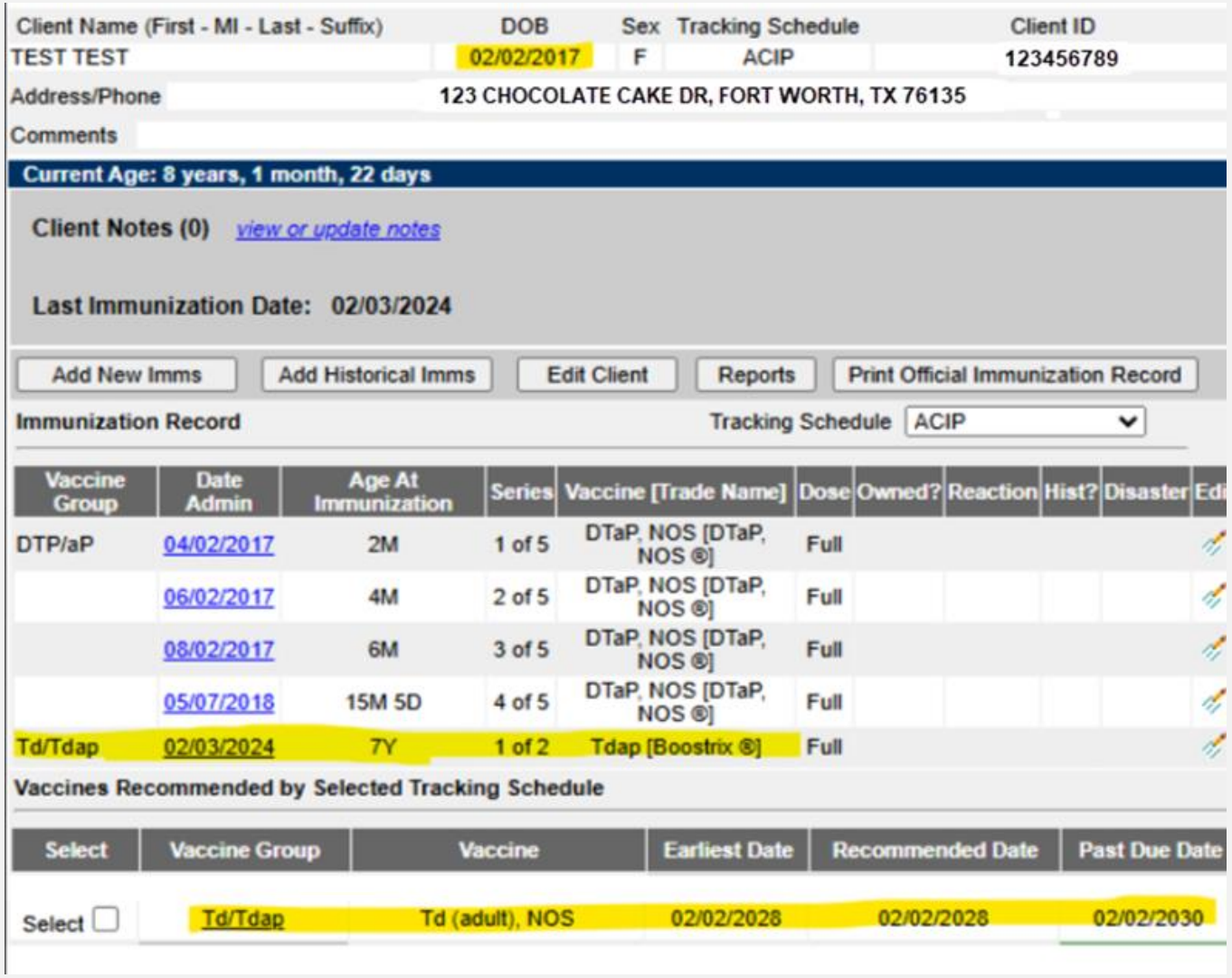
Vaccines Recommended by Selected Tracking Schedule

Select	Vaccine Group	Vaccine	Earliest Date	Recommended Date	Past Due Date
Select ☐	HPV	HPV, NOS	03/25/2023	04/25/2023	12/22/2023

HPV schedule now detects if a child received an immunization earlier than recommended interval, it forecasts the next dose according to the ACIP recommendation of 5 months from the first dose.

Results

Tdap schedule identifies if a child received Tdap vaccine before the recommended age of 11 years and forecast the next dose at 11 years of age.



Client Name (First - MI - Last - Suffix)	DOB	Sex	Tracking Schedule	Client ID
TEST TEST	02/02/2017	F	ACIP	123456789

Address/Phone: 123 CHOCOLATE CAKE DR, FORT WORTH, TX 76135

Comments:

Current Age: 8 years, 1 month, 22 days

Client Notes (0) view or update notes

Last Immunization Date: 02/03/2024

Add New Imms | Add Historical Imms | Edit Client | Reports | Print Official Immunization Record

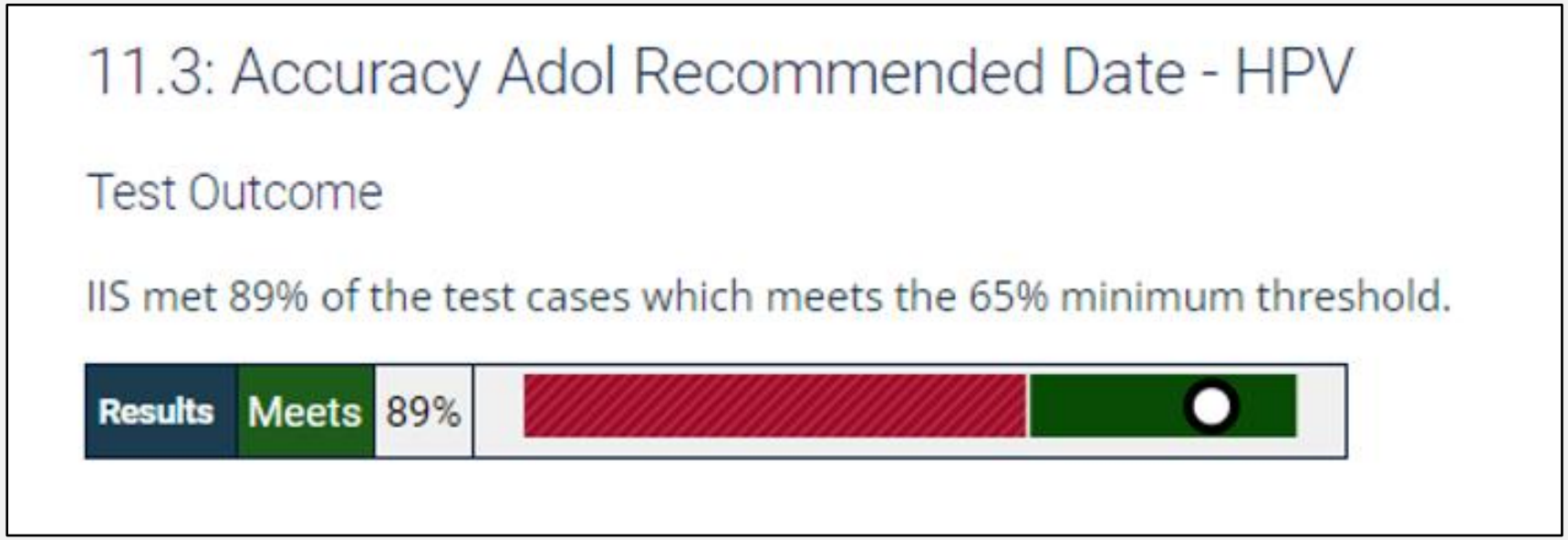
Immunization Record — Tracking Schedule: ACIP

Vaccine Group	Date Admin	Age At Immunization	Series	Vaccine [Trade Name]	Dose	Owned?	Reaction	Hist?	Disaster	Edi
DTP/aP	04/02/2017	2M	1 of 5	DTaP, NOS [DTaP, NOS ®]	Full					
	06/02/2017	4M	2 of 5	DTaP, NOS [DTaP, NOS ®]	Full					
	08/02/2017	6M	3 of 5	DTaP, NOS [DTaP, NOS ®]	Full					
	05/07/2018	15M 5D	4 of 5	DTaP, NOS [DTaP, NOS ®]	Full					
Td/Tdap	02/03/2024	7Y	1 of 2	Tdap [Boostrix ®]	Full					

Vaccines Recommended by Selected Tracking Schedule

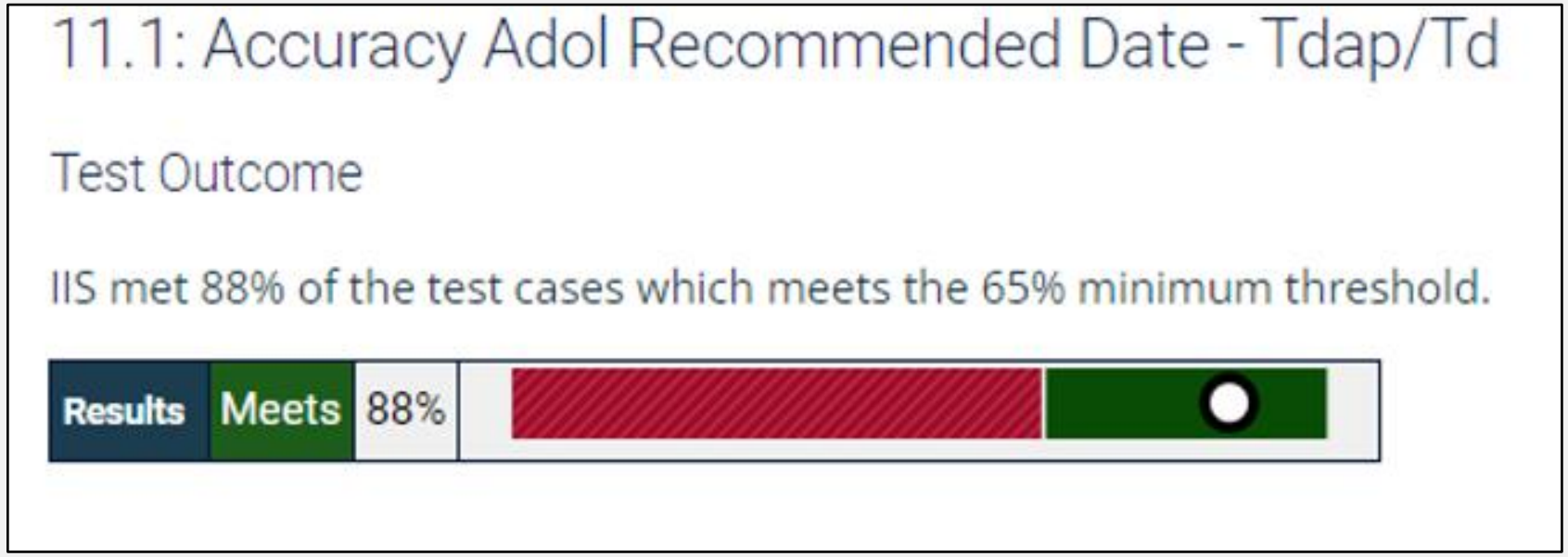
Select	Vaccine Group	Vaccine	Earliest Date	Recommended Date	Past Due Date
Select ☐	Td/Tdap	Td (adult), NOS	02/02/2028	02/02/2028	02/02/2030

Results Cont..



- HPV Forecasting:
  - Initial State: 53% of HPV schedules met AART standards.
  - Post Implementation: Forecasting accuracy improved to 89%.

Results Cont..



- Tdap Forecasting:
  - Initial State: Less than 60% accuracy identified with Tdap forecasting.
  - Post Implementation: Forecasting accuracy now at 88%.

Challenges

- Understanding CDSi documentation and expectations in AART validation.
- Variability in guidelines for risk-based populations.
- Time consuming process identifying areas of improvement.
  - Change-Test-Repeat.
- Disruption in interdependent schedules.
- Understanding time and spacing in schedules and applying rules on when to override.

Conclusion

- By introducing updated schedules and backend changes, we successfully enhanced the forecasting accuracy for HPV and Tdap vaccines.
- We intend to continue testing and refining vaccine scheduling systems for other vaccines to ensure broad validation compliance.
- Schedule accuracy leads to better clinical-decision making and ensures adherence to immunization timelines.
- Adherence to immunization timelines improves immunization coverage rates in children and adolescents.

Thank you!