Clinical Decision Support for Immunizations as a Community-drive, Standards-based Activity

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Topics

- The Business Case for CDS for Immunizations [Noam]
- Knowledge Development: CDC CDSi [Stuart]
- Open Source Implementation: HLN's ICE [Noam]
- Real-world Implementation: NYC Provider and Patient portals [Angel]

Business Case for CDS for Immunization

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Examples of Immunization Forecasting

Evaluations (of immunization history)

- The Polio shot that was administered to the patient on June 1, 2013 was INVALID.
- The Td shot that was administered to the patient on March 15, 2014 was VALID.

Recommendations

- The patient's next Meningococal vaccine is DUE ON SEPTEMBER 20, 2015.
- The patient has COMPLETED their MMR immunizations.

4

Obstacles to Implementing and Maintaining CDS for Immunizations

- Decisions change simply with the passage of time (patient ages)
- 36+ immunizations by age 12
- New vaccines coming to market
- Evolving guidelines from the Advisory Committee on Immunization Practices (ACIP)
- Different protocols followed in different clinical settings
- Often dependence on one or two key staff member to maintain
- Burden of regression testing test cases age
- Competing priorities, both for EHR/PHRs and public health
- Lack of consistent funding to support ongoing maintenance

Recommended Immunization Schedule Birth - 18 Years

(http://www.cdc.gov/vaccines/schedules/downloads/child/0-18yrs-child-combined-schedule.pdf)

Figure 1. Recommended immunization schedule for persons aged 0 through 18 years – United States, 2014.

(FOR THOSE WHO FALL BEHIND OR START LATE, SEE THE CATCH-UP SCHEDULE [FIGURE 2]).

These recommendations must be read with the footnotes that follow. For those who fall behind or start late, provide catch-up vaccination at the earliest opportunity as indicated by the green bars in Figure 1. To determine minimum intervals between doses, see the catch-up schedule (Figure 2). School entry and adolescent vaccine age groups are in bold.

Vaccine	Birth	1 mo	2 mos	4 mos	6 mos	9 mos	12 mos	15 mos	18 mos	19-23 mos	2-3 yrs	4-6 yrs	7-10 yrs	11-12 yrs	13-15 yrs	16-18 yrs
Hepatitis B ¹ (HepB)	1* dose	< 2 nd	dose ·····>		<		3 rd dose		>							
Rotavirus ² (RV) RV1 (2-dose series); RV5 (3-dose series)			1 [#] dose	2 nd dose	See footnote 2											
Diphtheria, tetanus, & acel- lular pertussis ³ (DTaP: <7 yrs)			1ª dose	2 nd dose	3 rd dose		-	≺ 4 th	dose ·····>			5 th dose				
Tetanus, diphtheria, & acel- Iular pertussis⁴ (Tdap: ≥7 yrs)														(Tdap)		
Haemophilus influenzae type b ^s (Hib)			1 [#] dose	2 [™] dose	See footnote 5		3 rd or 4 See for	th dose,> otnote 5								
Pneumococcal conjugate ^₅ (PCV13)			1 [#] dose	2 nd dose	3 rd dose		≺ ····· 4 th (dose>								
Pneumococcal polysaccha- ride ^e (PPSV23)																
Inactivated poliovirus ⁷ (IPV) (<18 yrs)			1ª dose	2 nd dose	◄		···· 3 rd dose ··		>			4 th dose				
Influenza ^a (IIV; LAIV) 2 doses for some: See footnote 8						A	nnual vaccin	ation (IIV only	n			An	nual vaccina	tion (IIV or LA	uv)	
Measles, mumps, rubella ⁹ (MMR)							<mark>≺</mark> ····· 1*o	dose>				2 nd dose				
Varicella ¹⁰ (VAR)							<mark>≺ 1×</mark> c	dose>				2 nd dose				
Hepatitis A ¹¹ (HepA)							<mark>∢</mark> 2·	dose series, s	See footnote 1	11 >						
Human papillomavirus ¹² (HPV2: females only; HPV4: males and females)														(3-dose series)		
Meningococcal ⁷³ (Hib-Men- CY ≥ 6 weeks; MenACWY-D ≥9 mos; MenACWY-CRM ≥ 2 mos)						See foo	tnote 13							1 [#] dose		Booster
Range of recommended ages for all children	or	Rang ages immu	e of recomi for catch-u inization	mended p		Range of ages for groups	f recomme certain hig	nded h-risk		Range of during w encoura high-risk	f recomment hich catch ged and for aroups	nded ages -up is r certain	[No	t routinely ommende	d

This schedule includes recommendations in effect as of January 1, 2014. Any dose not administered at the recommended age should be administered at a subsequent visit, when indicated and feasible. The use of a combination vaccine generally is preferred over separate injections of its equivalent component vaccines. Vaccination providers should consult the relevant Advisory Committee on Immunization Practices (ACIP) statement for detailed recommendations, available online at http://www.cdc.gov/vaccines/hcp/acip-recs/index.html. Clinically significant adverse events that follow vaccination should be reported to the Vaccine Adverse Event Reporting System (VAERS) online (http://www.vdc.gov/vaccines/top/acip-recs/index.html. Solution should be reported to the state or local health department. Additional information, is available from CDC online (http://www.cdc.gov/vaccines/vaccines/vaccines/vaccines/top/acip-recs/index.html) or by telephone (800-232-4636)].

This schedule is approved by the Advisory Committee on Immunization Practices (http://www.cdc.gov/vaccines/acip), the American Academy of Pediatrics (http://www.aap.org), the American Academy of Family Physicians (http://www.aafp.org), and the American College of Obstetricians and Gynecologists (http://www.aaog.org).

NOTE: The above recommendations must be read along with the footnotes of this schedule.

Complex! – (*e.g.,* Footnote #13: Meningococcal Conjugate Vaccines)

- Meningococcal conjugate vaccines. (Minimum age: 6 weeks for Hib-MenCY [MenHibrix], 9 months for MenACWY-D [Menactra], 2 months for MenACWY-CRM [Menveo])
 - Routine vaccination:
 - Administer a single dose of Menactra or Menveo vaccine at age 11 through 12 years, with a booster dose at age 16 years.
 - Adolescents aged 11 through 18 years with human immunodeficiency virus (HIV) infection should receive a 2-dose primary series of Menactra or Menveo with at least 8 weeks between doses.
 - For children aged 2 months through 18 years with high-risk conditions, see below.
 - Catch-up vaccination:
 - Administer Menactra or Menveo vaccine at age 13 through 18 years if not previously vaccinated.
 If the first dose is administered at age 13 through 15 years, a booster dose should be administered at
 - age 16 through 18 years with a minimum interval of at least 8 weeks between doses.
 - If the first dose is administered at age 16 years or older, a booster dose is not needed.
 - For other catch-up guidance, see Figure 2.
 - Vaccination of persons with high-risk conditions and other persons at increased risk of disease: • Children with anatomic or functional asplenia (including sickle cell disease):
 - For children younger than 19 months of age, administer a 4-dose infant series of MenHibrix or Menveo at 2, 4, 6, and 12 through 15 months of age.
 - For children aged 19 through 23 months who have not completed a series of MenHibrix or Menveo, administer 2 primary doses of Menveo at least 3 months apart.
 - 3. For children aged 24 months and older who have not received a complete series of MenHibrix or Menveo or Menactra, administer 2 primary doses of either Menactra or Menveo at least 2 months apart. If Menactra is administered to a child with asplenia (including sickle cell disease), do not administer Menactra until 2 years of age and at least 4 weeks after the completion of all PCV13 doses.
 - Children with persistent complement component deficiency:
 - For children younger than 19 months of age, administer a 4-dose infant series of either MenHibrix or Menveo at 2, 4, 6, and 12 through 15 months of age.
 - For children 7 through 23 months who have not initiated vaccination, two options exist depending on age and vaccine brand:
 - a. For children who initiate vaccination with Menveo at 7 months through 23 months of age, a 2-dose series should be administered with the second dose after 12 months of age and at least 3 months after the first dose.
 - b. For children who initiate vaccination with Menactra at 9 months through 23 months of age, a 2-dose series of Menactra should be administered at least 3 months apart.
 - c. For children aged 24 months and older who have not received a complete series of MenHibrix, Menveo, or Menactra, administer 2 primary doses of either Menactra or Menveo at least 2 months apart.
 - For children who travel to or reside in countries in which meningococcal disease is hyperendemic or epidemic, including countries in the African meningitis belt or the Hajj, administer an ageappropriate formulation and series of Menactra or Menveo for protection against serogroups A and W meningococcal disease. Prior receipt of MenHibrix is not sufficient for children traveling to the meningitis belt or the Hajj because it does not contain serogroups A or W.
 - For children at risk during a community outbreak attributable to a vaccine serogroup, administer or complete an age- and formulation-appropriate series of MenHibrix, Menactra, or Menveo.
 - For booster doses among persons with high-risk conditions, refer to MMWR 2013; 62(RR02);1-22, available at http://www.cdc.gov/mmwr/preview/mmwrhtml/rr6202a1.htm.
 - Catch-up recommendations for persons with high-risk conditions;
 - If MenHibrix is administered to achieve protection against meningococcal disease, a complete ageappropriate series of MenHibrix should be administered.
 - If the first dose of MenHibrix is given at or after 12 months of age, a total of 2 doses should be given at least 8 weeks apart to ensure protection against serogroups C and Y meningococcal disease.
 - For children who initiate vaccination with Menveo at 7 months through 9 months of age, a 2-dose series should be administered with the second dose after 12 months of age and at least 3 months after the first dose.
 - For other catch-up recommendations for these persons, refer to MMWR 2013; 62(RR02);1-22, available at http://www.cdc.gov/mmwr/preview/mmwrhtml/rr6202a1.htm.

But a good candidate for development!

- Routine, lifelong events
- With all its complexity, knowledge relatively stable with general consensus clinically
- Good results achievable; serves as a good "test case" for CDS overall

<u>*Clinical Decision Support for Immunizations (CDSi): A Comprehensive, Collaborative Strategy,* **Biomedical Informatics Insights,** Suppl. 2, October 2016. <http://www.la-press.com/clinical-decision-support-for-immunizations-cdsi-a-comprehensive-colla-article-a5971-abstract?article_id=5971></u>

Knowledge Development: CDC CDSi

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Clinical Decision Support

- More commonly referred to as vaccine forecasting and evaluation services by the immunization community.
- Performed by many different computer systems:
 - Electronic Health Record Systems (EHRs)
 - Immunization Information Systems (IIS)
 - Stand-alone applications Web-based schedulers, smart phone apps, etc.

Computer Systems and ACIP Integration

- New ACIP schedule changes are communicated through scientific language.
- Recommendations were interpreted and integrated by technical and clinical subject matter experts (SMEs).
 - Translation into technical logic is time-consuming.
 - The schedule is complex.
 - The schedule changes frequently.
- Computer systems are decentralized and do not share a common technology or logic framework.
 - Integration occurred mostly independently.
 - Implementation was often specific to a given application and implementation setting.

Bridging the Gap

The Clinical Decision Support for Immunization (CDSi) resources bridge the gap between the scientific ACIP recommendations and the IT world of computer systems.

- Designed to work in a wide variety of computer systems.
 - Doesn't require a single tool to be used.
 - Need to able to support all software tools using ACIP logic
- Promotes consistent interpretation of ACIP recommendations in a wide variety of tools.
- Helps ensure a patient's immunization status is current, accurate, and consistent regardless of where the provider is located in the US.

Sources of Knowledge



Before the Clinical Decision Support for Immunization (CDSi) Project





ACIP Recommendations with Communication and Education Branch (CEB) Clarifications



Individual Implementation Consistent System Recommendations

Project Clarification

The Project Is Not	The Project Is
New vaccine recommendations	A catalog of existing ACIP recommendations in a computer-friendly format
A software application	Computable and implementation-neutral logic framework and data that can be used by a variety of different systems and configurations
A replacement for current computer systems	Clarification and validation for existing systems or guidelines to improve systems



CDSi Project Timeline

v1.0 - 2013

- Birth through 18
- Limited Immunities & Contraindications

v2.0 - 2015

- Birth to Death
- Limited
 Immunities &
 Contraindications

v3.0 - 2016

- Birth to Death
- Risk Factors
- Immunities
- Contraindications
- Travel

Open Source Implementation: HLN's ICE

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Goal of the ICE Project

Create an immunization decision support system that:

Objective	Achievement
Supports routinely administered vaccine groups	 Supports 15 vaccine groups from birth through adulthood
Promotes clinical best practices	Follows ACIP recommendationsInformed by CDC's CDSi project
Adapts to changing requirements	 Tools that allow self-administration where practical Automated testing tool w/2,700+ test cases Engineered for high performance and scalability
Easily integrates with IIS and other health systems	Standards-based architecture and APIsVariety of deployment options
Software and knowledge base freely available	 Standard, permissive open-source license (LGPL v3) Downloadable from public website

Original ICE Collaborators

New York City Citywide Immunization Registry

21

- HLN Consulting, LLC
- Alabama Dept of Public Health
- OpenCDS Team
 - Software platform and toolkit
 - Open source
 - Standards-based
 - Web Service interface
 - Collaborative project: Dr. Kensaku
 Kawamoto at University of Utah



Sample ICE Deployment



Software Architecture

ICE/OpenCDS

- Servlet Container
- JBoss Drools (rule
- HL7 Decision Supplication
- HL7 Virtual Medici
- CAT (CDS Adminis
 - Application Server
 - JavaServer Faces
 - Enterprise JavaBe
 - JDBC compliant data

1	Over	view	3
2	Puro	ose of this Document	6
3	Com	municating with the ICE Service	7
	3.1	Invoking ICE as a Decision Support Service	7
	3.2	Virtual Medical Record Format (VMR)	9
	3.3	ICE Input Message	9
		3.3.1 Input Message Format	11
		3.3.2 Sample Input Message	14
		3.3.3 Input Node Elements and Attributes	16
	3.4	ICE Output Message	21
		3.4.1 Output Message Format	22
		3.4.2 Sample Output Message	26
		3.4.3 Output Node Elements and Attributes	33
4	Code	e Tables	47
	4.1	Vaccines	47
		4.1.1 CVX - Code System 2.16.840.1.113883.12.292	47
		4.1.2 Vaccines by Vaccine Group	48
	4.2	HL7 Administrative Gender - Code System 2.16.840.1.113883.5.1	50
	4.3	SNOMED - Code System 2.16.840.1.113883.6.5	50
	4.4	Disease Immunity Value - Code System 2.16.840.1.113883.3.795.12.100.8	51
	4.5	Disease Immunity Focus - Code System 2.16.840.1.113883.6.103	51
	4.6	Disease Immunity Reason - Code System 2.16.840.1.113883.3.795.12.100.9	51
	4.7	Evaluation Validity - Code System 2.16.840.1.113883.3.795.12.100.2	51
	4.8	Evaluation Focus (Vaccine Group) - Code System 2.16.840.1.113883.3.795.12.100.1	51
	4.9	Evaluation Reason - Code System 2.16.840.1.113883.3.795.12.100.3	52
	4.10	Recommendation Value - Code System 2.16.840.1.113883.3.795.12.100.5	53
	4.11	Recommendation Focus (Vaccine Group) - Code System 2.16.840.1.113883.3.795.12.1 53	100.1
	412	Recommendation Reason - Code System 2 16 840 1 113883 3 795 12 100 6	53

Deployments of ICE

- eClinicalWorks, National EHR (De
- CareDox, National PHR (November CareDox, National PHR (November CareDox, National PHR (November CareDox, National PHR (November CareDox, National PHR (November)
- Denver Public Health (July 2016)
- Selected and Tested by Veteran's
- Major Academic Medical Center (1)
- New Jersey IIS (January 2018)
- GE Centricity (through H1Tech, S
- vxVistA (Scheduled for 2018)
- New York City IIS (Scheduled for
- Rhode Island KIDSNET (Schedule
- Other organizations evaluating ICE...



For work optimizing the vaccine and immunization system



hhs.gov/nvpo/awards

Update Process Flow & Advisory Structure



ICE Resources

- Basic information: <u>https://www.hln.com/ice/</u>
- Main public wiki page: <u>https://cdsframework.atlassian.net/wiki/display/ICE/Home</u>
- Wiki page with documentation of the rules/philosophy: <u>https://cdsframework.atlassian.net/wiki/display/ICE/Default+Immuni</u> <u>zation+Schedule</u>
- Software download/documentation page: <u>https://cdsframework.atlassian.net/wiki/display/ICE/Downloads</u>

Product Roadmap:

https://cdsframework.atlassian.net/wiki/spaces/ICE/pages/77365249 /Roadmap

Real-world Implementation: NYC

Noam Arzt for Angel Aponte

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New York Citywide Immunization Registry (CIR)

- NYC's Immunization Information System
- Established in 1996
- Mandatory reporting of immunizations for patients 0-18 years of age
- 6.5 million patient records
- 90 million immunizations
- Population-based
 - Birth certificates loaded twice a week
- Uses legacy ICE version 2 implementation (before Open ICE)
- Migrating to Open ICE in coming months



To help manage and update your list, use the Refresh MyList feature.

S To view a patient record, click on the patient's name.

To Remove from List, check one or more boxes and click the "Remove" button at the bottom of the page. (The selected patients will no longer appear on this page. They will not be deleted from the Registry.)

Who's in MyList? Refresh MyList Export to XLS

You may update a patient's status to let CIR know if the patient is no longer being seen at your practice. Click the Yes/No toggle in the Active column to the left of the patient's name. Update the information at the bottom of "Update Patient Info" screen that appears.



Provider View:

						LE	GEND				
🕖 =immun	izations DUE N	ow		Immunizations DU	IE SOON		Immunizations UP TC	DATE	=Immunization s	tatus not ava	ailable
Remove	CIR Id	Active	Imm Status	Last/First	Gender	DOB	Address	Home Phone	Mobile Phone	Accepts Texts	Last Accessed
	908330793	Yes	€)	Test, Abcs A Den	F	01/01/1950	100 Elm New York, NY 10011	555-555-5555		No	11/27/2017
	908581651	Yes	•	Test, Apple	F	01/01/2000	45 831st Brooklyn, NY 11126	347-347-5637		No	12/20/2017
	908117907	Yes	•	Test, Male	м	01/01/2000	1 Reg Dog House Mickey, MO 14563			No	12/21/2017
	908485215	Yes	⊌	Test, Test	м	06/03/1984	123 Test, 2 Bronx, NY 10000		917-319-0521	Yes	01/11/2018
	908308053	Yes	⊌	Test, Test	F	10/10/1933	2 Ny New York, NY 10000			No	01/08/2018
	749171463	Yes	⊌	Test, Test	м	08/24/2010	123 Trashcan Alley, 99 New York, NY 12345	718-234-1234	718-234-1234	No	11/01/2017
	908430541	Yes	⊌	Test, Test	F	01/01/2000	15 Hulbert St Auburn, NY 13021	716-555-6666	716-555-6666	Yes	09/28/2017
	908485211	Yes	•	Test, Test	м	06/16/1978	123 Test, 2C Brooklyn, NY 88888			No	07/05/2017
	908308728	Yes	⊌	Test, Test	F	01/10/1987	999 Test St., A Queens, NY 11105			No	12/28/2016
	908467315	Yes	⊌	Test-Kiru, Test-Jean	F	10/26/2016	999 Test Ignore St. New York, NY 12345			No	10/17/2017
Remove											
									1-10 of 25 n	natching rec	ords 1 <u>2 3</u>

29



Search MyList Reports Add/Edit Tools Recall Adv. Event VIM Set Up Adult PHelp CogOut Online Registry 0 990 de Welcome Angel Aponte (SSA) Facility: Citywide Immunization Registry (CIR) Address: 42-09 28 STREET +3 0.7 View Record Print Reports Pre-completed Forms and Referrals Update Patient Info X •

PRACTICE

Printer-Friendly Format 🖶

First: Middle: Last: DOB: Gende Gold Test Fish 05/05/2015 F Gender: 905057548 1 Fishbowl (Age: 2y 8m) Ny, NY 10010

Scroll down to Lead Test History

PATIENTS

Immunization History						
Event	1	2	3	4	5	Next Due
Influenza 0 Event/s						DUE NOW INFLUENZA
HepB 0 Event/s						DUE NOW HEP B PEDS <20 YRS
Rotavirus 0 Event/s						Not recommended after 8 months.
DTP 1 Event/s	12/14/2017 DTaP (DAPTACEL) 2y 7m					DUE NOW DTAP
Hib 0 Event/s						DUE NOW HIB
Pediatric Pneumococcal (PCV & PPSV) 3 Event/s	01/01/2016 Pneumococcal polysaccharide (Pneumovax) 7m 3w	03/01/2016 Pneum Conj (PCV13) 9m 3w	05/01/2016 Pneum Conj (PCV13) 11m 3w			DUE NOW PNEUM CONJ (PCV13)
Polio 0 Event/s						DUE NOW IPV
MMR 3 Event/s	04/29/2016 MMR 11m 3w	05/25/2016 MMR 12m 2w	01/11/2018 MMR 2y 8m			Completed Vaccine Series
Varicella 0 Event/s						DUE NOW VARICELLA
HepA 0 Event/s						DUE NOW HEPA PED/ADOL 2-DOSE
Meningococcal (MenACWY) 0 Event/s						Recommended for high risk groups, otherwise 05/05/2026 MENACWY CONJUGATE
Human Papillomavirus 0 Event/s						05/05/2026 HUMAN PAPILLOMAVIRUS (HPV9-GARDASIL 9)

Provider View:



Month and Year

EHR to IIS Integration Features

Automatic or Manual

- Immunization queries and uploads
- Reconciliation of immunization information
- Decision support update when new information is added to EHR
- EHR or IIS clinical decision support module
- User interface, color coding, and context-sensitive help
 - Immunization information source
 - Valid and invalid shots
 - Shots due now
 - Forecast to schedule appointment for future shots

MDLand

-0	line i e®	Medicine, Internal	, MD MDLand Demo A	ccount Sign Out	
16		ting Room Test, T	est X BABYGIRL	, ONEYEAR ×	
ashboard	Patient Home	OLD M (02/13/2015 1)	Female) Attending: N	ledicine Internal Refer	alt
(V) Salting	Save QRefresh	ollow Up Action	Ø Return Chan	ge Specialty(Internal Med	licine)
Z	Patient Home Visit History	Medical History Paym	nent/Account Msg/Act	ivity	
Register	Vaccine	Last CIR Downle	oad: 2016-02-29(Today)	Last CIR Upload:	2016-02-29(Today)
Patient	New Vaccine Past Vac	cine Vaccine Invent	ory Record Up/Dow	vnload 🗊 Delete Selecte	d 📃 Select All Vaccin
Schedule	Vaccine Group	1	2	3	Next Due
Inbox Outbox	DTaP/DT/Td/Tdap	04/10/2015 DTaP-Hib-IP (120)	06/15/2015 DTaP-Hib-IP (120)	09/15/2015 DTaP-Hib-IP (120)	05/14/2016 DTaP (20)
ab Order	H1N1 Influenza No longer recommended				
Health	Нер А				02/13/2016 Hep A, ped/ (83)
Followup	Нер В				02/13/2015 Hep B, adol (08)
Biling	нір	04/10/2015 DTaP-Hib-IP (120)	06/15/2015 DTaP-Hib-IP (120)	09/15/2015 DTaP-Hib-IP (120)	05/14/2016 Hib (PRP-T) (48)
Account	HPV				02/13/2026 HPV, unspec (137)
nventosy	Influenza	12/05/2015 Influenza, (161)	02/29/2016 Influenza, (140)		08/01/2016 influenza, (88)
Reports	Meningococcal				02/13/2026 meningococc (114)
Settings	MMR/Measles/Rubella	02/01/2016 MMR (03)			02/29/2016 MMR (03)

Hx Imm Scho	edule Flu	Schedule	i i		C	ild, Twoye	aroid (F) 0	2/10/2014 (2Y)
						Inn For	ecast. All	Y
lmm.Series 🐠	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7	Forecast 🗭
Hepatitis B 2 shots	02/10/2014 0D Hep8 peds.	06/10/2014 4M Hepli peds.	Add					08/10/2014 DUE NOW
Rotavirus 0 shot	Add							Not Recommen_
DTP 3 shots	05/10/2014 4M DTaP-Hib	10/10/2014 8M DTaP-Hib	04/10/2015 14M DTaP-Hib	Add				10/10/2015 DUE NOW
HIB 3 shots	05/10/2014 4M DTaPHib	10/10/2014 8M DTaP-Hib	04/10/2015 14M DTaPHib					Complete
PCV 3 shots	04/10/2014 2M Pneumococ.	06/10/2014 4M Pneumococ	10/10/2014 8M Pneumococ	Add				02/10/2016 DUE NOW
PPSV 0 shot	Add							02/10/2079 Future Recom
Polio 3 shots	05/10/2014 4M DTaPHib	10/10/2014 8M DTaPHib	04/10/2015 14M DTaPHib	Add				02/10/2018 Future Recom
MMR 1 shot	02/03/2015 11M 21D MMR	Immunizatio	n Name: MM INVALID	IR				05/08/2015 DUE NOW
Varicella 1 shot	04/10/2015 14M Varicella	Interpretation App	n: Below Mini	imum Age f	or Series			02/10/2018 Future Recom

-	Immunization Name	Given Date
C	DTaP-IPV/Hib (Pentacel)	04/10/2015
0	DTaP-IPV/Hib (Pentacel)	06/10/2014
0	DTaP-IPV/Hib (Pentacel)	10/10/2014
C	Influenza-IIV4, IM, Presrv-free (>=3yrs)	10/10/2015
С	Hep B, adolescent or pediatric	02/10/2014
C	Hep B, adolescent or pediatric	06/10/2014
C	varicella	04/10/2015
C	MMR	02/03/2015
e	Pneumococcal, PCV-13	04/10/2014
C	Pneumococcal, PCV-13	06/10/2014
C	Pneumococcal, PCV-13	10/10/2014
C	Pneumococcal, PCV-13	04/10/2015

- 23

eClinicalWorks uses Open ICE

Immunizations/T.Injections



Consumer Access: My Vaccine Record

	1							
			R	lesults				exit session
Sign up to rec	eive immuniz	ation messa	iges from the Hea	Ith Department	when this feature	e becomes availa	able.	
Tex	t Messages:	• Yes O	No Cell Number	347396240	00			
Em	ail Messages:	• Yes O	No Email Addres	ss test@healt	h.nyc.gov	save		
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Questions? Comments?