RELIABILITY OF IZ COVERAGE RATES USING IMMUNIZATION INFORMATION SYSTEMS DATA

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2016 AIRA IIS National Meeting

LIVE WELL SAN DIEGO

STRENGTHENING HEALTH SYSTEMS THROUGH INTERPROFESSIONAL EDUCATION

A collaboration between the Association of State and Territorial Health Officials, Centers for Disease Control and Prevention, the Council of State and Territorial Epidemiologists, the National Association of County and City Health Officials, and the Public Health Informatics Institute.

Vision Statement: *Illuminate pathways for professionals, organizations, and communities to achieve a collective, transformative, and sustainable impact on population health.*

SHiNE — Strengthening Health Systems through Interprofessional Education

LIVE WELL SAN DIEGO

APHiF — Applied Public Health Informatics Fellowship

QUESTION

- How accurate are population-based coverage rates based on data generated from a local immunization information system (IIS) in a voluntary reporting state?

IMMUNIZATION COVERAGE RATES

COVERAGE RATES ARE USED TO

Determine how well a population is up to date on vaccinations

Identify groups at risk of vaccine-preventable diseases

Monitor progress toward coverage targets

Stimulate efforts to increase coverage
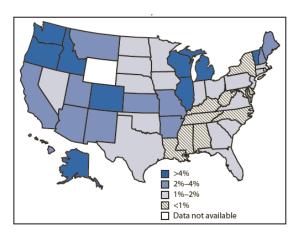
Evaluate how well efforts work
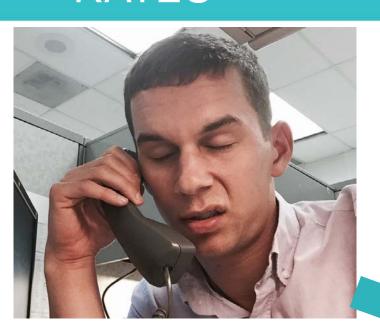
COVERAGE RATES MAY BE

- Generated for *individual* practices, as those used for AFIX

- Determined on a *population* basis, such as National Immunization Survey (NIS)
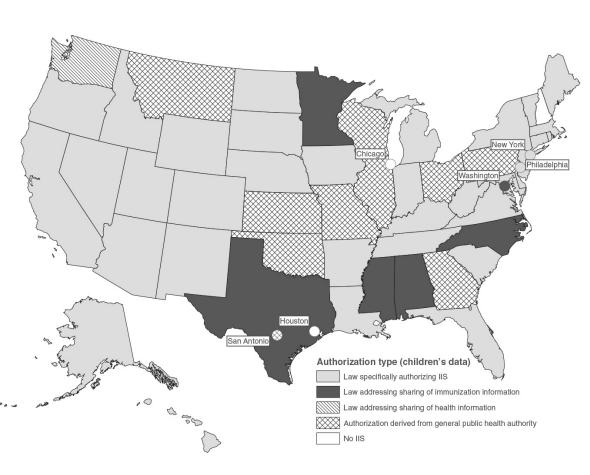
IMMUNIZATION COVERAGE RATES

- Coverage rates obtained in San Diego using Random Digit Dialing (RDD) telephone surveys
- Costly in time and resources

It would be efficient and cost effective to utilize IIS data vaccine coverage estimates

IIS CDC-GRANTEES

- **49 states**
  - New Hampshire excluded
- **3 municipalities**
  - New York City
  - Philadelphia
  - San Antonio
- **District of Columbia**
- **= 53 total**

Authorization type (children's data)

- Law specifically authorizing IIS
- Law addressing sharing of immunization information
- Law addressing sharing of health information
- Authorization derived from general public health authority
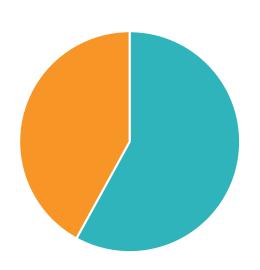- No IIS

- Published reports focus on <u>adolescents</u> in states where there is <u>mandatory reporting</u> by all medical providers
- Most states require that some entities report immunizations to their IIS
  - Public providers
  - Private providers
  - Pharmacies
  - Health Plans
  - VFC
  - Medicaid
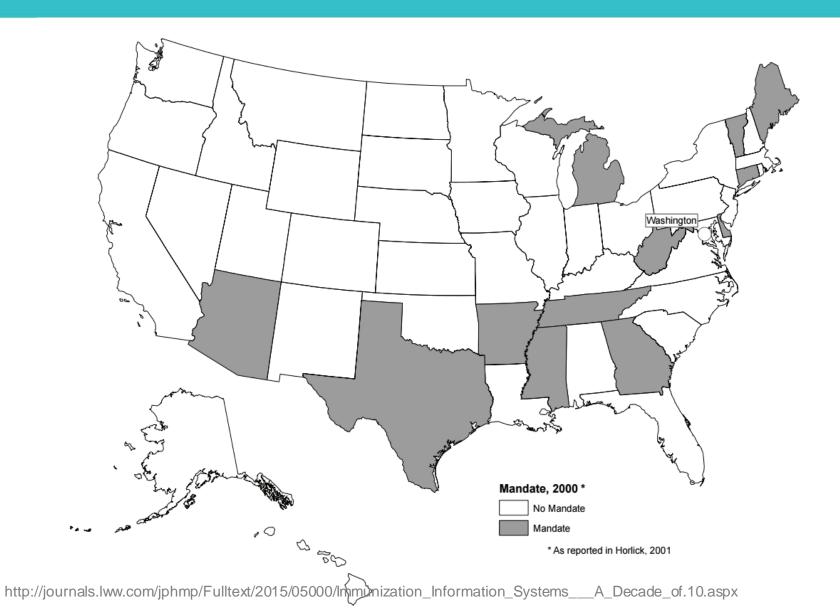
MANDATE TO REPORT IMMUNIZATIONS

- 31 (58.5%) jurisdictions required at least 1 type of provider or entity to report immunizations to their IIS

- **22 (41.5%) had no requirement to report immunizations**

Mandate, 2000 *

No Mandate

Mandate

* As reported in Horlick, 2001
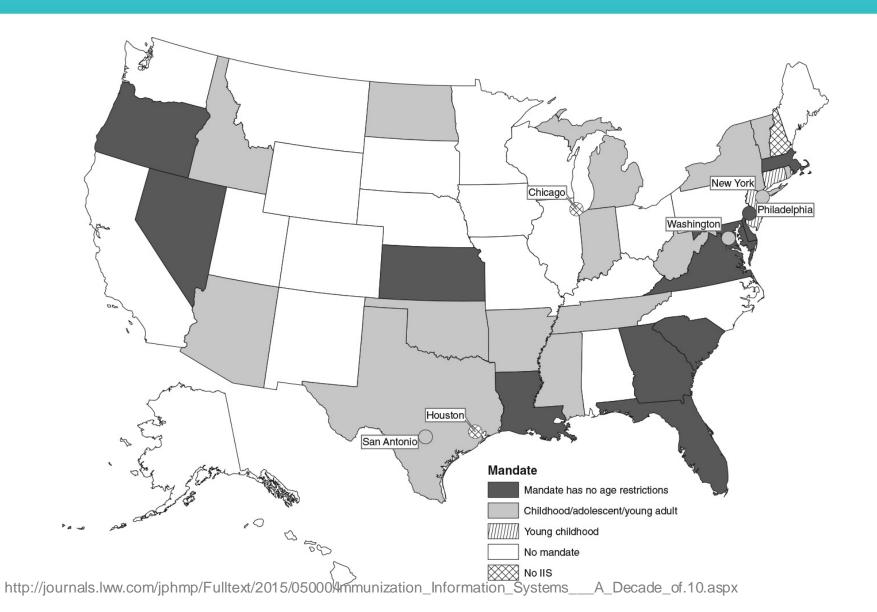
- Registry data may not provide reliable estimates in <u>voluntary</u> reporting states due to lower participation

- California is a voluntary reporting state

- **Development of statistical methods to adjust registry data to better represent the overall population is essential**

LIVE WELL
SAN DIEGO

SAN DIEGO
HEALTH CONNECT

90%
expected
by 2018

Meaningful U

STAGE 1
Data capture
and sharing

STAGE 2
Advanced
clinical
processes

As IIS provider participation increases, numbers will soon generate more valid coverage rates…

but when?

SDIR provider
participation
~65%
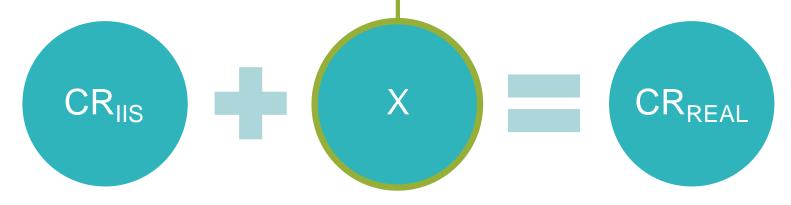
MODEL BUILDING

- San Diego Immunization Registry does not currently have enough data to produce a coverage rate

$$Y = \beta_0 + \beta_1 \text{gender} + \beta_2 \text{race} + \beta_3 \text{ethnicity} + \beta_4 \text{age} + \beta_5 \text{region} + \beta_6 \text{language} + \beta_7 \text{source} + \beta_8 \text{VFC}$$

- **Want to build a model to get us there**

CR_{IIS} ✚ X = CR_{REAL}

PROJECT OBJECTIVES

- Produce county-wide vaccine coverage rate estimate using IIS data – model building

- Supplant costly local survey – save up to ~$250K every two years for comprehensive data

- Determine agreement between RDD and IIS

- Share results via presentations or publications

SAN DIEGO IMMUNIZATION REGISTRY (SDIR)

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ELECTRONIC IMMUNIZATION INFORMATION SYSTEM (IIS) USED TO IMPROVE IMMUNIZATION LEVELS

Database for patient medical record retention and mobility

"Vaccine due" forecast to providers (clinical decision support)
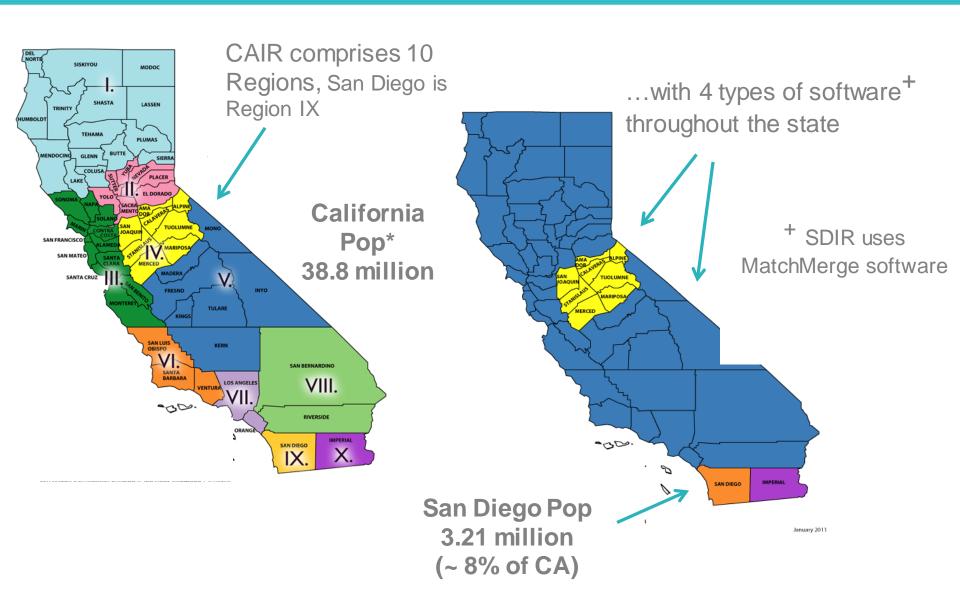
Reduces over- or under-vaccination; increases community immunization coverage rates

Confidential, secure – SDIR operates under California Health and Safety Code 120440

SDIR

CAIR comprises 10 Regions, San Diego is Region IX

California Pop* 38.8 million

…with 4 types of software[+] throughout the state

[+] SDIR uses MatchMerge software

San Diego Pop 3.21 million (~ 8% of CA)
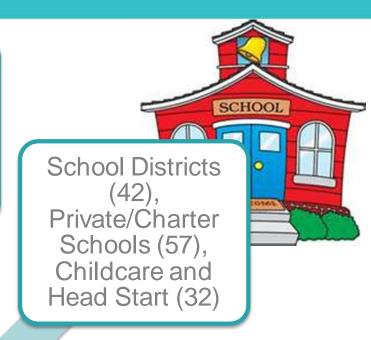
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WIC (5), County programs (45), and Health Plans (4)

Medical Systems – Scripps, Sharp, Palomar, Tri-City

School Districts (42), Private/Charter Schools (57), Childcare and Head Start (32)

Public and private health care facilities (186)

SDIR
san diego regional Immunization registry

Colleges – Alliant University, Mira Costa College, SDCC

SDIR DATA INPUT

Manual web-based use ~ **40% records**

Electronic exchange / Interfaces ~ **60% records**

12 active interfaces

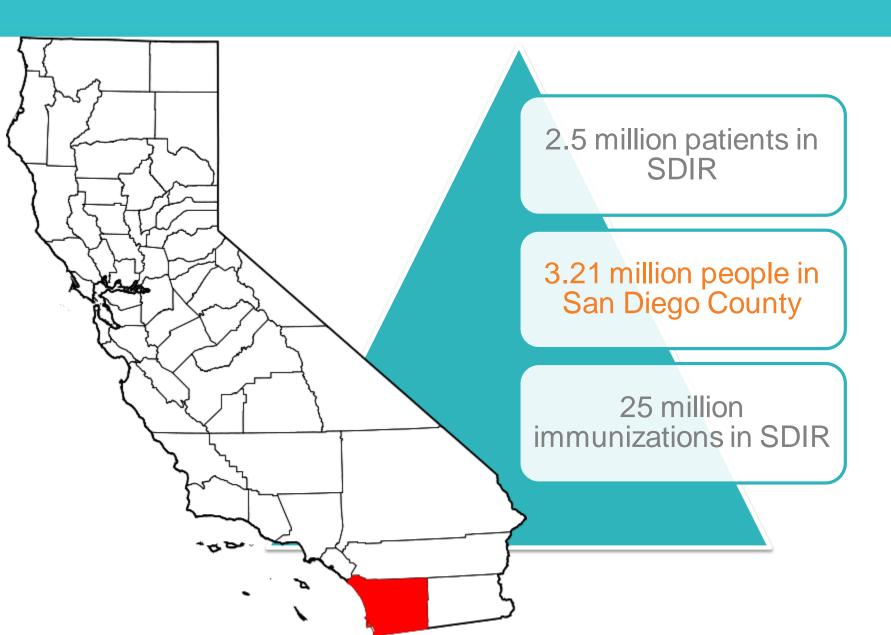**65 pending** interfaces

~100 expected interfaces (*2017*)

SDIR CAPACITY

2.5 million patients in SDIR

3.21 million people in San Diego County

25 million immunizations in SDIR

LIVE WELL SAN DIEGO

4:3:1:3:3:1:4 SERIES

LIVE WELL SAN DIEGO

Children 19-35 months of age were up-to-date if they had:

- **4 doses** of Diphtheria, Tetanus, and Pertussis (DTaP)
- **3 doses** of Polio vaccine (IPV)
- **1 dose** of Measles, Mumps, and Rubella (MMR)
- **3 doses** of Hepatitis B (HBV)
- **3 doses** of Haemophilus influenzae type b (Hib)
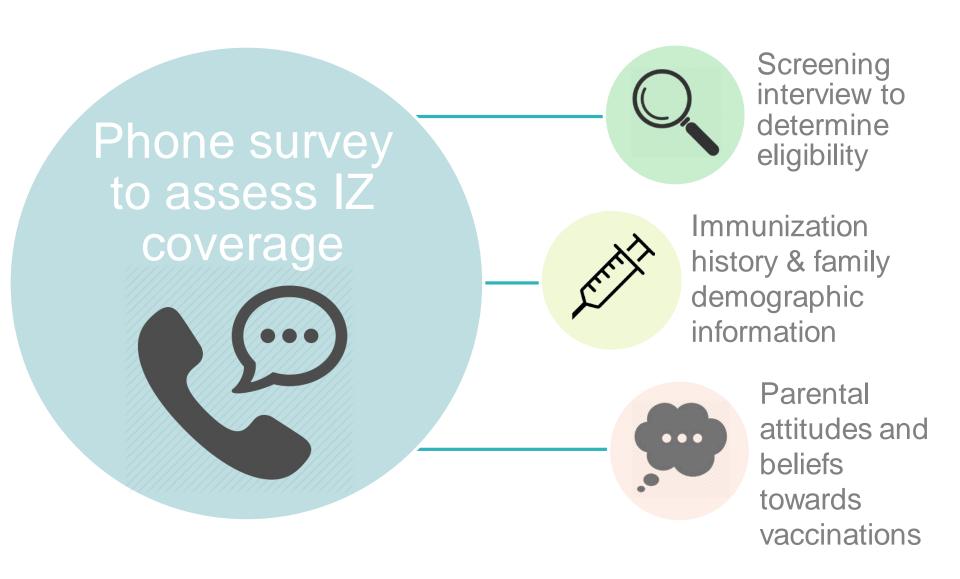- **1 dose** of Varicella
- **4 doses** of Pneumococcal Conjugate Vaccine (PCV)

Vaccine ▼ Age ▶	Birth	1 month	2 months	4 months	6 months	12 months	15 months	18 months	19–23 months	2–3 years	4–6 years
Hepatitis B[1]	HepB	HepB			HepB						
Rotavirus[2]			RV	RV	RV[2]						
Diphtheria, Tetanus, Pertussis[3]			DTaP	DTaP	DTaP	see footnote[3]	DTaP				DTaP
Haemophilus influenzae type b[4]			Hib	Hib	Hib[4]	Hib					
Pneumococcal[5]			PCV	PCV	PCV	PCV				PPSV	
Inactivated Poliovirus[6]			IPV	IPV	IPV						IPV
Influenza[7]					Influenza (Yearly)						
Measles, Mumps, Rubella[8]						MMR		see footnote[8]			MMR
Varicella[9]						Varicella		see footnote[9]			Varicella
Hepatitis A[10]						HepA (2 doses)				HepA Series	
Meningococcal[11]										MCV4	

Range of recommended ages for all children

Range of recommended ages for certain high-risk groups

RANDOM DIGIT DIAL (RDD) SURVEY

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SD County has used RDD since 1995; modeled after CDC/NIS

Measure of adherence to recommended childhood immunizations

If parent/guardian gave permission, staff contacted healthcare providers who administered vaccines to verify info collected

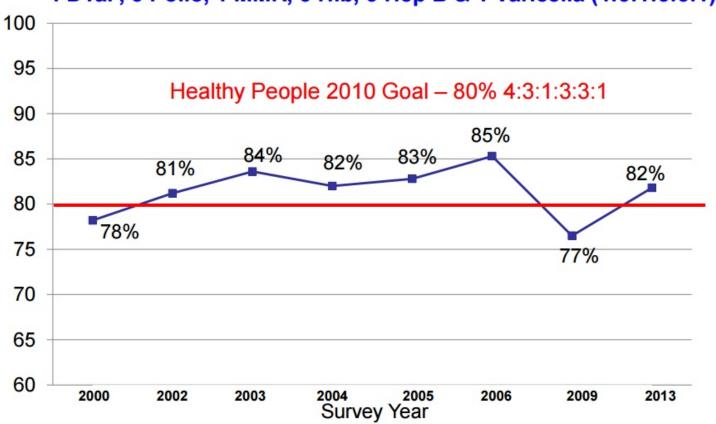IIS was also checked to verify immunization records

finally.

2016 – Last RDD survey?
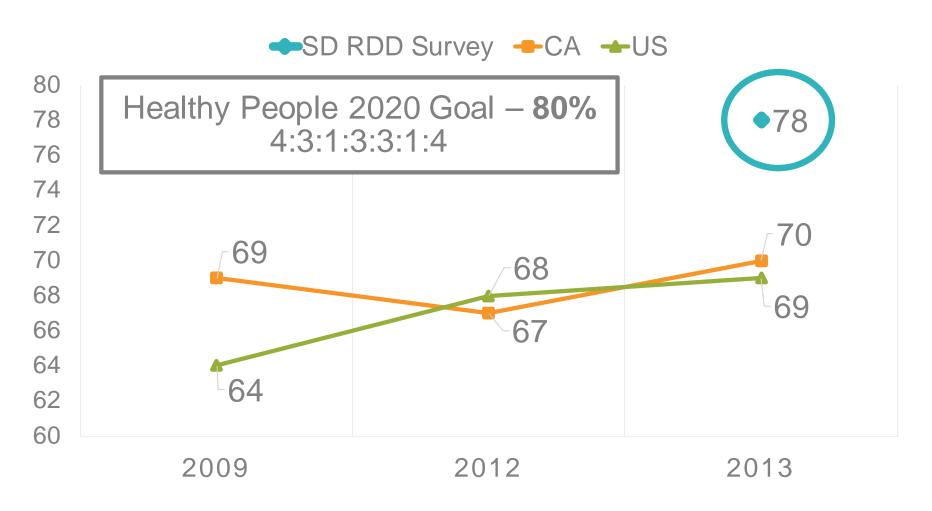
San Diego RDD 2013
Percent of children (19-35 months) fully immunized with
4 DTaP, 3 Polio, 1 MMR, 3 Hib, 3 Hep B & 1 Varicella (4:3:1:3:3:1)

PERCENT OF CHILDREN AGES 19-35 MONTHS FULLY IMMUNIZED

4 DTAP, 3 POLIO, 1 MMR, 3 HIB, 3 HEP B, 1 VARICELLA & 4 PCV (4:3:1:3:3:1:4)

Legend: SD RDD Survey, CA, US

Healthy People 2020 Goal – **80%**
4:3:1:3:3:1:4

2013: SD RDD Survey 78

CA: 2009 = 69, 2012 = 67, 2013 = 70
US: 2009 = 64, 2012 = 68, 2013 = 69

RDD 2013 SAMPLE

~**200,000** phone calls

> ~**500** (19-35m)

> ~**350** have records
> ~**150** no records

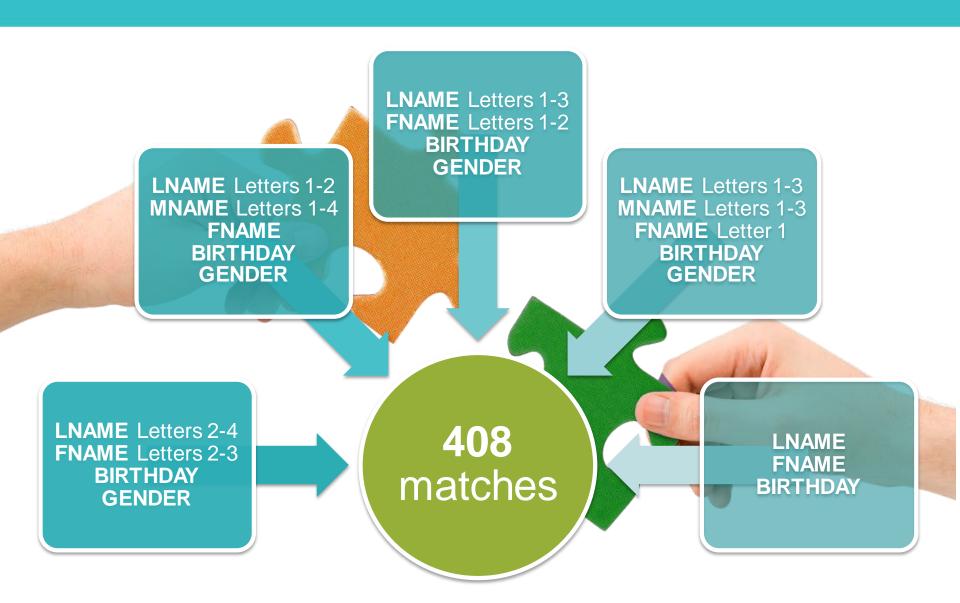> **80%** allowed to verify with provider

> ~**400** final count

STUDY POPULATION

- Parents or legal guardians living in San Diego County having a child 19-35 months of age in the home
- 553 completed surveys used to assess coverage rates
  - 435/553 (78.7%) consented to have IZ record verified by provider
  - 430/553 (77.8%) consented to provide names
    - **430 records available for matching** with IIS

MATCHING **RDD** WITH **IIS**

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LNAME Letters 1-3
FNAME Letters 1-2
BIRTHDAY
GENDER

LNAME Letters 1-2
MNAME Letters 1-4
FNAME
BIRTHDAY
GENDER

LNAME Letters 1-3
MNAME Letters 1-3
FNAME Letter 1
BIRTHDAY
GENDER

LNAME Letters 2-4
FNAME Letters 2-3
BIRTHDAY
GENDER

408 matches

LNAME
FNAME
BIRTHDAY

SAMPLE FOR COMPARISON

553 RDD participants

430 with names

408 in IIS

292 had IZ records in 2013

DATA ANALYTIC PLAN
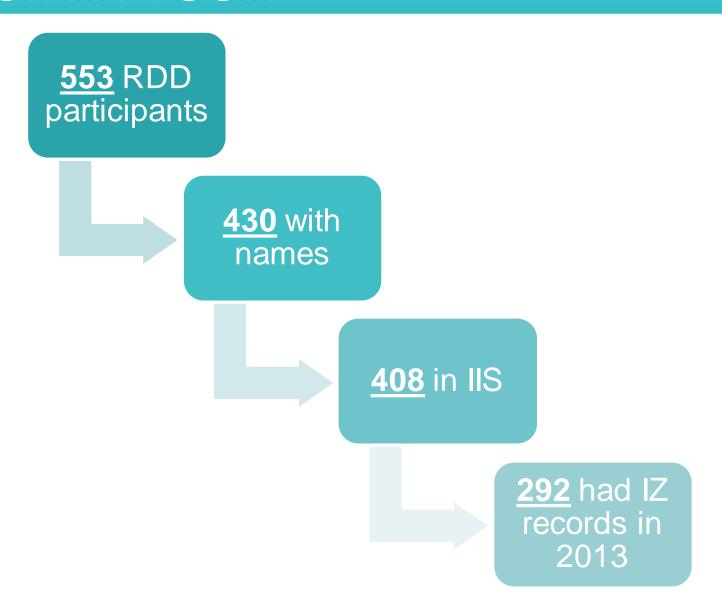
- Analysis employs a two stage technique
  - Model building with retrospective data
  - Model validation with prospective data
- Overview
  - Descriptive statistics
  - Univariate analyses
  - Predictive Modeling

Zip Code
VFC
Source

Gender
Ethnicity
Race
Language
Age

Select most **recent** value

Select most **frequent** value

DATA ANALYTIC PLAN

- Outcome variable is % coverage or threshold coverage (dichotomous)
- Descriptive statistics
  - Thorough exploration of the data
    - Frequencies of demographics
    - Frequencies of characteristics
    - Proportions of immunizations
  - Coverage rates using current IIS data

UNIVARIATE ANALYSES

- Distribution assumptions

- T-tests (continuous), Chi-square analyses (categorical):

  - Covariates for multivariable modeling

  - Geographic variation

  - Kappa statistics

  - Investigation for confounders

		Diseased	
		Yes	No
Exposed	Yes	(A)	(B)
	No	(C)	(D)

DATA ANALYTIC PLAN
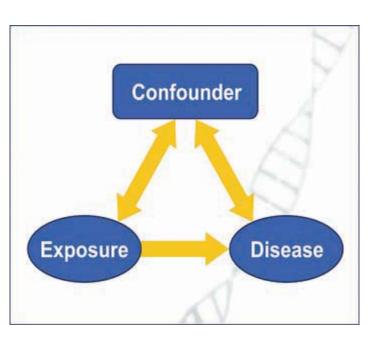
PREDICTIVE ANALYSES

- Regression models
  - Standardized coefficients
  - Predictors investigated and ranked /stb
- Sensitivity and specificity as well as C-statistic
- Mining; classification tree analysis

GENERAL CONSIDERATIONS

- Model assumptions examined
- Collinearity will be investigated

- Data explored for missing values
  - Complete case analysis
  - Multiple imputation techniques
- All analyses performed using SAS V.9.3

DEFINING KAPPA

- Kappa measures degree of nonrandom agreement between IIS and RDD

$$K = \frac{Pr(a) - Pr(e)}{1 - Pr(e)}$$

This study:

- 0.8 and 1.0 = 'Greater than substantial agreement'
- 0.6 and 0.8 = 'substantial agreement'
- 0.4 and 0.6 = 'moderate agreement'
- 0.2 and 0.4 = 'fair agreement
- 0.0 and 0.2 = 'slight or poor agreement'

- **'Substantial agreement' or higher represents no practical difference between IIS and RDD**

KAPPA TESTS

Agreement between IIS and RDD using Kappa statistics

Vaccine	Y/N Simple Kappa	Weighted Kappa by Dose
DTaP (4)	0.46	0.37
Polio (3)	0.30	
MMR (1)	0.31	0.31
Hib (3)	0.34	
HBV (3)	0.19	0.20
Varicella (1)	0.35	
PCV (4)	0.48	0.41
Overall (4:3:1:3:3:1:4)	0.35	0.37

Moderate agreement

Fair agreement

Slight or poor agreement

CR$_{IIS}$ & CR$_{REAL}$ CHILDREN AGES 19-35 MO.
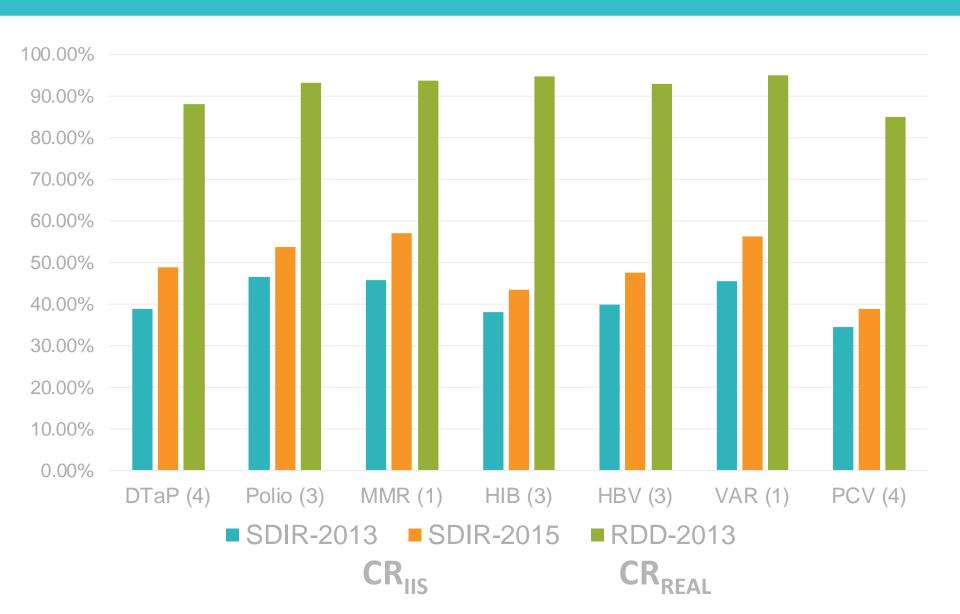
Vaccine	CR$_{IIS}$ (Limited*)		CR$_{REAL}$
	IIS-2013	IIS-2015	RDD-2013
DTaP (4)	38.9%	49.0%	88.0%
Polio (3)	46.7%	53.8%	93.2%
MMR (1)	45.9%	57.0%	93.7%
HIB (3)	38.2%	43.5%	94.7%
HBV (3)	40.0%	47.5%	92.9%
VAR (1)	45.5%	56.3%	95.0%
PCV (4)	34.6%	38.8%	85.1%

* The IIS does not comprise all area population data, so coverage rates are dependent on provider participation

CR_IIS & CR_REAL CHILDREN AGES 19-35 MO.

IIS DESCRIPTIVE FREQUENCIES 2013 - CR$_{IIS}$

Characteristic	Total %	DTAP: Received vaccine prevalence	POLIO: Received vaccine prevalence	MMR: Received vaccine prevalence	HIB: Received vaccine prevalence	HEP B: Received vaccine prevalence	VAR: Received vaccine prevalence	PCV: Received vaccine prevalence
Gender								
Female	48.1	39.4	47.2	46.4	48.5	40.3	46.0	34.2
Male	50.9	38.8	46.6	45.7	47.9	39.9	45.3	33.9
Missing	1.0	21.6	32.5	28.9	32.3	29.4	28.5	15.8
Race								
Am Indian	0.3	56.9	73.3	71.5	76.5	69.4	69.4	56.9
Asian	1.8	71.4	78.7	77.2	81.4	60.4	76.7	55.5
Native Hawaiian	1.5	61.6	76.6	76.6	78.5	60.8	76.3	52.1
Black	0.2	70.7	80.5	80.1	83.7	56.1	79.3	52.0
Other Race	5.9	70.8	80.6	80.1	83.4	59.7	79.3	55.9
White	13.9	64.4	72.7	72.9	Missing data		72.0	51.8
Missing	76.4	30.4	37.8	36.8			36.5	27.9
Ethnicity								
Hispanic	11.1	71	80.9	80.1	81.8	72.6	79.6	64.0
Not Hispanic	13.1	62.3	74.8	75.8	77.9	58.1	74.9	54.3
Missing	75.8	29	36.9	35.7	37.9	32.1	35.4	25.9
Language								
English	81.4	35.5	42.3	41.5	43.8	35.1	41.1	30.8
Other	13.1	62	72.7	72.7	72.2	69.5	72.4	55.6
Missing	5.5	34.1	51.0	47.2	52.4	42.3	46.0	27.8
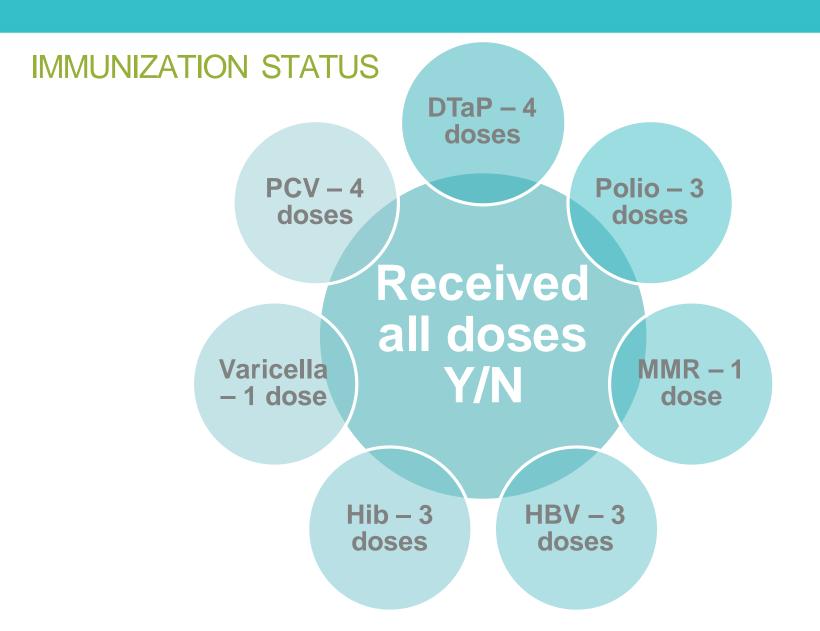
IIS DESCRIPTIVE FREQUENCIES 2013 - CR$_{IIS}$

Characteristic	Total %	DTAP: Received vaccine prevalence	POLIO: Received vaccine prevalence	MMR: Received vaccine prevalence	HIB: Received vaccine prevalence	HEP B: Received vaccine prevalence	VAR: Received vaccine prevalence	PCV: Received vaccine prevalence
Region								
1	8.2	56.4	64.3	63.6	66.6	58.1	62.8	51.3
2	6.4	63.9	72.8	71.7	76.1	57.2	71.3	51.5
4	8.3	65.3	78.3	77.1	79.1	70.0	76.4	55.8
5	6.1	61.1	75.0	76.0	76.1	62.9	76.0	51.4
6	8.5	53.6	62.6	63.1	65.3	52.9	62.2	46.8
Other	3.8	54.2	63.8	60.4	66.9	51.8	59.4	44.4
3	7.9	63.1	76.2	78.4	_(Missing data)_	.3	77.9	57.6
Missing	50.8	18.6	23.5	22.0	24.2	19.6	21.8	16.5
Source								
Comm Clinics	19.1	57.9	71.7	69.0	71.4	68.6	68.6	53.7
Private Providers	9.3	38.1	47.4	46.2	50.5	35.4	45.6	35.9
Large Systems	22.8	65.8	75.4	77.2	79.3	58.0	76.5	53.5
Other	1.6	35.3	48.7	40.4	49.3	43.5	39.8	27.2
PH Centers	47.2	18.5	22.6	22.6	22.8	20.5	21.2	16.2
VFC								
Eligible-Medicaid	5.3	56.4	73.6	71.1	72.7	69.7	70.6	50.6
Eligible-Uninsured	3.5	65	81.3	77.0	79.9	81.1	75.3	58.5
Eligible-FQHC	14.4	79.8	86.0	87.6	89.5	66.7	86.7	64.9
Not VFC eligible	1.8	53.6	66.0	69.1	68.3	53.4	67.7	47.4
Missing	75.1	28.3	35.2	34.2	36.3	30.6	33.9	25.3
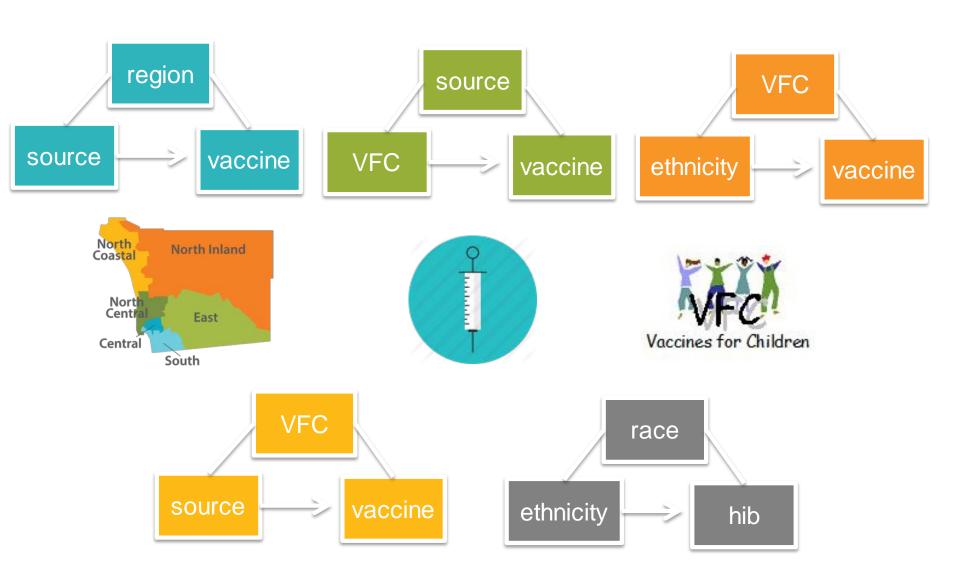
MEASURES – OUTCOMES

IMMUNIZATION STATUS

WHICH PREDICTORS ARE IMPORTANT IN THE IIS?

	Variable	VFC				Region		PCV
1	VFC							-0.4488
2	Region	-0.2700	-0.2738	-0.2901	-0.2409	-0.2909	-0.2885	-0.2313
3	Source	-0.1642	-0.24			2523	-0.2438	-0.1680
4	Ethnicity	-0.1561	-0.11			1018	-0.1295	-0.1438
5	Race	-0.1531	-0.15			2086	-0.1562	-0.0564
6	Age	0.1247	0.09			0789	0.0946	-0.0870
7	Language	-0.1209	-0.0930	-0.0862	-0.0041	-0.1226	-0.0880	-0.0782
8	Gender	0.0004	0.0012	0.0001	-0.0040	0.0020	-0.0010	-0.0071

STANDARDIZED COEFFICIENTS – __RDD__

WHICH PREDICTORS ARE IMPORTANT IN__RDD__?

Variable	DTaP	Poli...			...79	Varicella	PCV
Language	-0.1401	-0.0...				-0.2120	-0.1561
Insurance	-0.0062	0.2...			...81	-0.2211	-0.1224
Age	-0.1406	0.0...			...89	-0.1184	0.0362
Region	0.0639	0.1...			...02	0.1007	0.0695
Race	-0.0640	0.0...			...19	0.1886	-0.0749
Gender	-0.0281	-0.0857	-0.1600	-0.0061	-0.0010	-0.0913	-0.0364

1 2 3 4 5 6

Language

Insurance

FINAL MODEL - VARICELLA

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Adjusted Odds of immunization status for Varicella

Characteristic	AOR (95% CI)
Characteri... (Central)	0.54 (0.50, 0.59)
Female Ge... (...tral)	0.72 (0.67, 0.78)
Missing Ge...	..., 0.90)
Am. Indian	..., 0.42)
Asian Race	..., 0.23)
Native Haw...	..., 0.93)
African Am...	..., 1.47)
Other Race	..., 2.35)
Missing Ra...	..., 0.51)
Hispanic Ethnicity	..., 0.17)
Missing Ethnicity (ref: non-Hispanic)	0.98 (0.91, 1.06)
English Language (ref: other)	1.47 (1.40, 1.54)
Missing Language (ref: other)	0.74 (0.67, 0.80)
Age in months	1.04 (1.04, 1.04)
N Coastal Region (ref: Central)	0.41 (0.37, 0.44)

Characteristic	AOR (95% CI)
Region 1 (ref: 3)	0.41 (0.37, 0.44)
Reg...	
Reg...	
Reg...	
Reg...	
Mis...	

Characteristic	AOR (95% CI)
VFC Eligible-Medicaid (ref: non-eligible)	0.76 (0.67, 0.86)
VFC Eligible-uninsured (ref: non-eligible)	0.59 (0.51, 0.68)
VFC missing (ref: non-eligible)	0.15 (0.13, 0.17)
VFC other (ref: non-eligible)	0.53 (0.36, 0.77)

VFC other (ref: non-eligible)	0.53 (0.36, 0.77)
VFC Eligible-Medicaid (ref: non-eligible)	0.76 (0.67, 0.86)
VFC Eligible-uninsured (ref: non-eligible)	0.59 (0.51, 0.68)
VFC Eligible-FQHC (ref: non-eligible)	1.35 (1.19, 1.53)

[a] adjusted for all of the other variables listed in the model

FINDINGS

- A model based on lack of data is possible

- Identified components for a model and target fields that we need to improve

- **Language** and **Insurance** strong predictors for RDD

  - Ensure these values are being recorded in IIS

- Sample of responders to RDD survey may not be representative of target population

- One age strata (older strata have more gaps)

- Military – large SD pop but low representation

Sample

Population

- <u>Denominator adjustments</u>
  - Patient active and inactive status (PAIS)
  - Deceased (0-18, over 18)

STRENGTHS

- San Diego's population diversity (generalizability)
- Mature database
- All-ages covered
- Focus on ages 19-35 months
  - Age of most shots
  - Good number of pediatric providers
  - All births are loaded into the IIS

- 2016 RDD survey
  - Regression model adjustments
- Repeat analyses for other age groups
  - Adolescents
  - Adults
- NCOA service
- Heat map of vaccination coverage
- Collaboration and discussion with other IIS teams exploring population-based CR

SUMMARY

California is a voluntary reporting state

Registry information is not complete

Model building is possible

Cost effective methods other than surveys for coverage rates

Dramatic cost savings will result

ACKNOWLEDGEMENTS

Zachary Madewell[1], Rob Wester[1], Wendy Wang[2], Michael Peddecord[2], Tyler Smith[3], Heidi Deguzman[2], Jessica Morris[2], Mark Sawyer[2], Eric McDonald[1]

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FINAL SLIDE

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To learn more about Project SHINE, check out our website:
http://shinefellows.org

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