HIMSS18

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Conference & Exhibition | March 5–9, 2018

Las Vegas | Venetian – Palazzo – Sands Expo Center

CDS in the Cloud: Deploying a CDC Guideline for National Use

Session 239, March 8, 2018

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Conflict of Interest

Blackford Middleton, MD, MPH, MSc, FACP, FACMI, FHIMSS
Employee: Apervita, Inc., Harvard TH Chan School of Public Health
Consulting Fees: HL7, MITRE, Stanford Farm Ventures
Contracted Research: AHRQ Patient-centered Clinical Decision
Support Learning Network (Chair, Steering Committee)

Ninad Mishra, MD, MPH

Has no real or apparent conflicts of interest to report.

Agenda

- Background and Context (15 mins)
    - Clinical Issues in STD (Sexually Transmitted Disease) Diagnosis and Treatment
    - Informatics Issues for disseminating e-guidelines at scale
- CDC CDS Project and Methodology Review (15 mins)
- Implementation Overview (15 mins)
- Discussion / Questions & Answers (15 mins)

Learning Objectives

1. Identify the essential clinical pearls from the 2015 CDS Sexually Transmitted Disease Guideline pertaining to gonorrhea treatment, and describe the clinical decision support that is implemented

2. Define the current standards and capabilities to build "Smart on FHIR" applications using clinical logic executed in the cloud

3. Recognize the capabilities of the Apervita platform to encode clinical logic and express it in a variety of additional web-services and applications

4. Describe the ability to implement the clinical logic in the cloud and securely provision EHRs in use nationwide

5. Describe the ability to monitor performance of the clinical decision support to provide feedback to knowledge authors for refinement

Scaling CDS for Disseminating Guidelines in Public Health: A Case Example

- Clinical decision support (CDS) is a term used to describe the use of health information technology to encourage health care providers' adherence to clinical guidelines.

- These clinical guidelines can include recommended treatment regimens for health conditions of public health concern.

- The Public Health Informatics Institute (PHII), working under cooperative agreement with the Centers for Disease Control and Prevention (CDC), partnered with Apervita to advance CDS for STIs.

- This talk describes how CDC's gonorrhea treatment recommendations were converted into an electronic CDS knowledge artifact that conforms to current informatics standards.

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Clinical Background and Context

- In the US we are experiencing a near epidemic of STDs and growing patterns of antibiotic resistance among infecting agents.

- Antibiotic-resistant gonorrhea is particularly concerning:

  - *There are about **820,000** new gonorrhea infections each year in the U.S*

  - *Gonorrhea is the **2nd** most commonly reported infectious disease*

  - *We are down to **1 effective class of antibiotics***

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Clinical Issues with STD (Sexually Transmitted Disease) Care Management

- Complicated cases with recurrent and/or resistant disease may be seen by primary care providers with less familiarity with the guidelines

- Subtle differences in appropriate therapies depending on infection site

- Important to include care management considerations (partner evaluation, referrals, patient care handouts, etc.)

- Nuances of recommended care may require data not in EHR – therefore interactive dialogue with clinician who can obtain additional information from patient

Issues with Guideline Translation, Specification, and Dissemination for CDS (Clinical Decision Support) at Scale
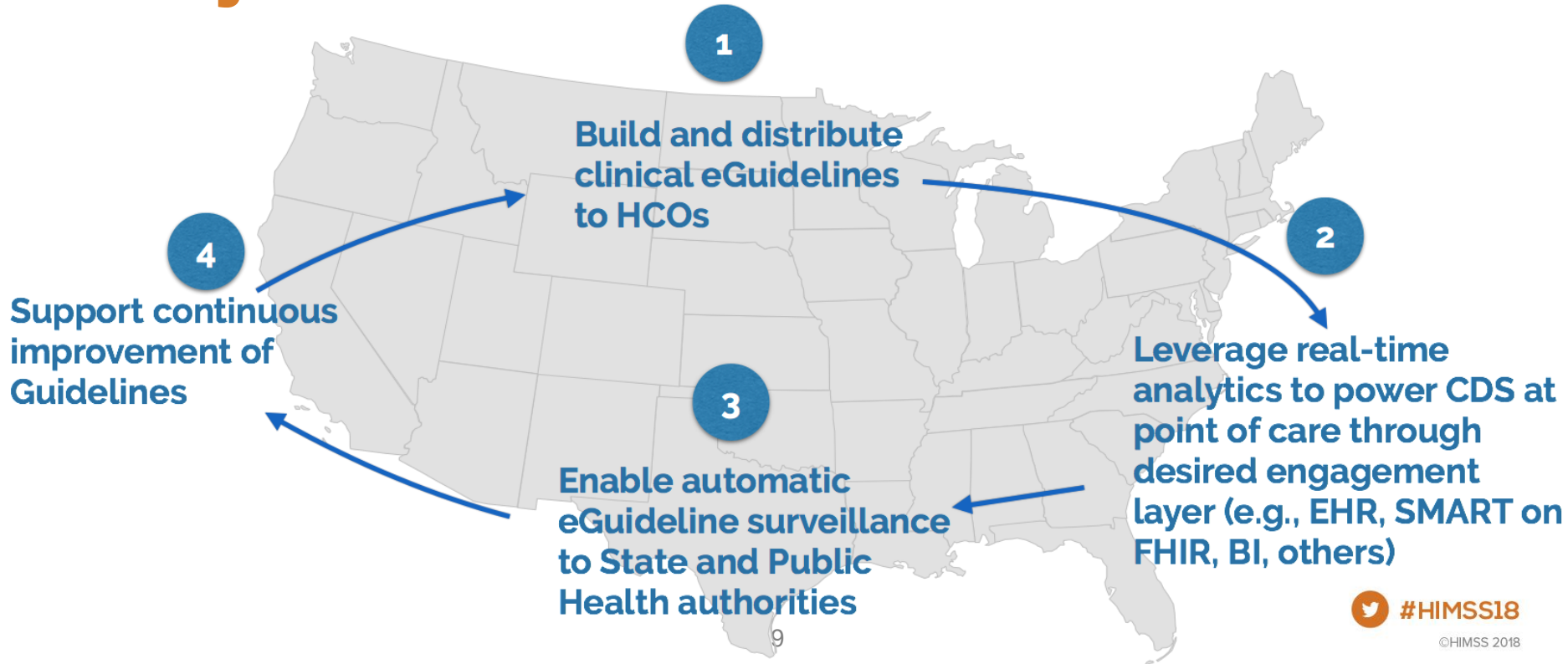
- Translating guidelines into knowledge artifacts is hard - not many HCOs have capability

- Specifying knowledge artifacts with detailed logic, terminologies, and expressions is betting better with CQL (Clinical Quality Language)

- Prior research has found the simplest approach is to use web services for CDS knowledge sharing (Health-e-Decisions Use Case 2)

- FHIR (Fast Health Interoperability Resources), SMART on FHIR apps, and CDS Hooks are methods used to access data and return CDS

- Challenges may still exist with semantic mappings, insertion of CDS into the clinical workflow

Wright A, Sittig DF, Ash JS, et al. Lessons learned from implementing service-oriented clinical decision support at four sites: A qualitative study. Int J Med Inform. 2015;84(11):901-911.
Goldberg HS, Paterno MD, Rocha BH, et al. A highly scalable, interoperable clinical decision support service. JAMIA. 2014;21(e1):e55-e62.

Project Vision

1 Build and distribute clinical eGuidelines to HCOs

2 Leverage real-time analytics to power CDS at point of care through desired engagement layer (e.g., EHR, SMART on FHIR, BI, others)

3 Enable automatic eGuideline surveillance to State and Public Health authorities

4 Support continuous improvement of Guidelines

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Where are We?

Yesterday

Today

- *Paper Guidelines*

- *Limited standards to represent knowledge and to access data*

- *High-cost, resource intensive one-off Guideline & CDS implementations*

- *Costly to maintain as Guideline evolves*
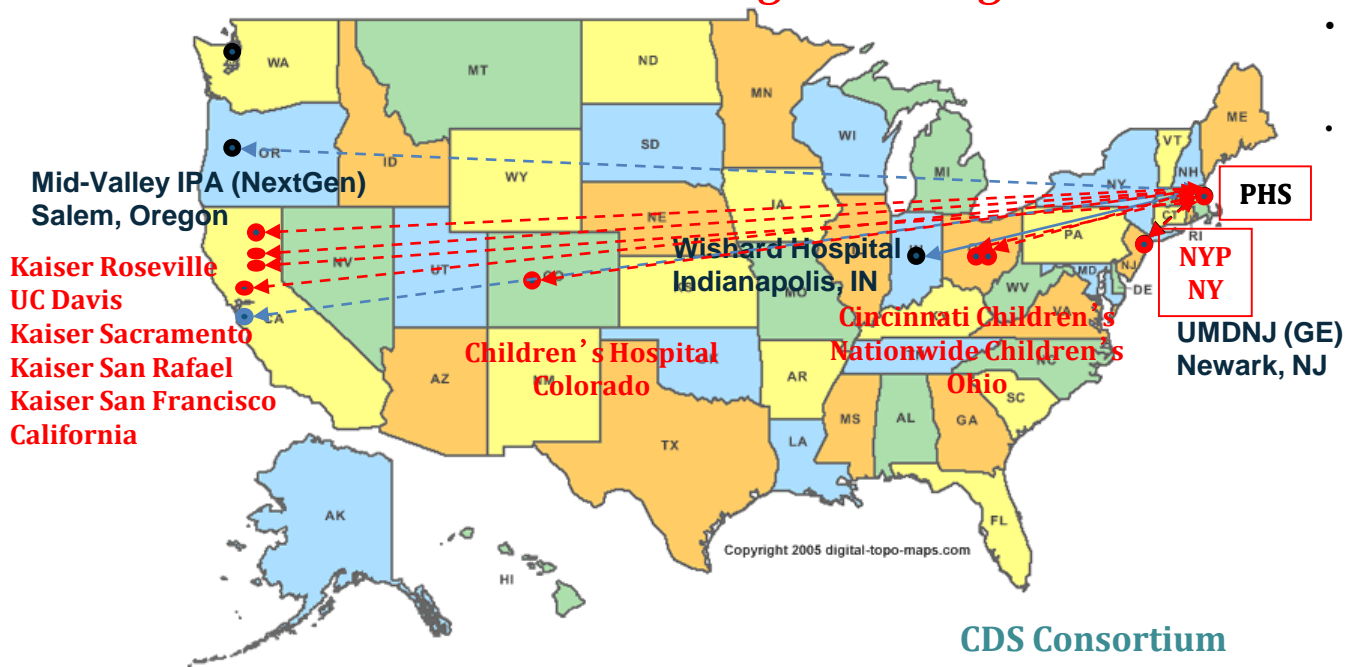
- *Difficult to assess efficacy*

- *Computable Guidelines*

- *Completely standards based and interoperable Guideline implementation*

- *Tools and infrastructure are available to deliver Guideline across multiple applications (e.g., EHR, Business Intelligence)*

- *Full lifecycle capabilities allow for knowledge asset maintenance*
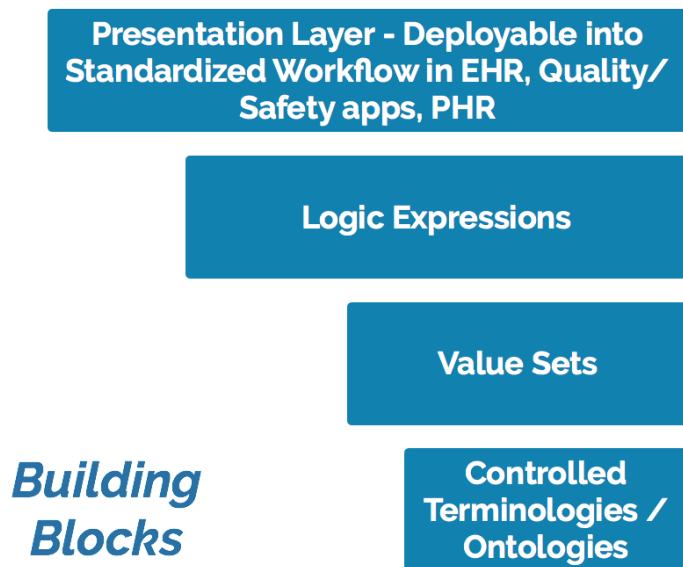
Little standards–based CDS in national use

Standards-based, interoperable eGuidelines & eCDS

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CDS Consortium Demonstrations: 2008-13

Toward a National Knowledge Sharing Service

Mid-Valley IPA (NextGen)
Salem, Oregon

Kaiser Roseville
UC Davis
Kaiser Sacramento
Kaiser San Rafael
Kaiser San Francisco
California

Children's Hospital Colorado

Wishard Hospital Indianapolis, IN

Cincinnati Children's
Nationwide Children's Ohio

PHS

NYP NY

UMDNJ (GE) Newark, NJ

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CDS Consortium

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PECARN TBI CDS

- Clinical Decision Support Consortium
  Middleton B, PI: 2008-13, AHRQ –funded: HHSA290200810010

- **Major accomplishments**:

- Knowledge artifacts published: 11 clinical rules, 50+ classification rules and 375 immunization schedule rules

  - 8 clinical sites implemented using 5 different EHRs

  - More than 240 users utilize CDS services

  - Established legal framework for collaboration

  - Since 2010 more than 1.7M CCD transactions were processed

  - 31 entities (companies and academics) in a pre-competitive environment

  - Contributed to ONC-sponsored Health-e-Decisions efforts: KAS 1 and KAS 2

How do we get There?
COMMON BUILDING BLOCKS FOR INTEROPERABLE CLINICAL REASONING

Presentation Layer - Deployable into Standardized Workflow in EHR, Quality/ Safety apps, PHR

Logic Expressions

Value Sets

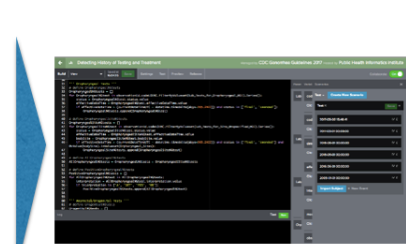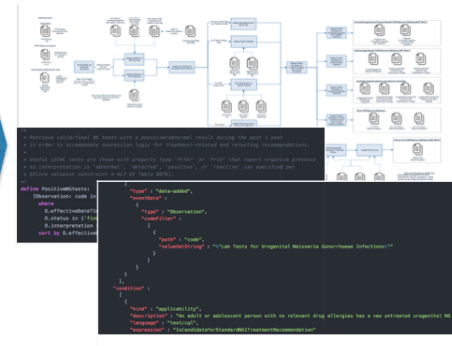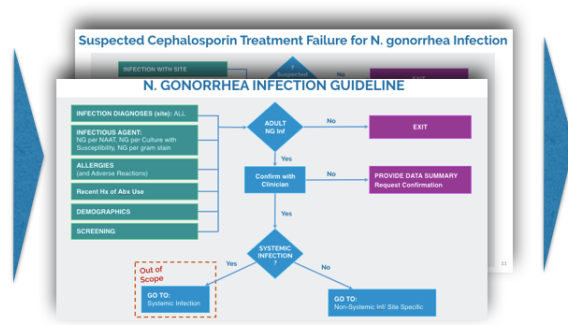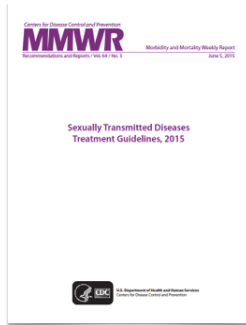**Controlled Terminologies / Ontologies**

Building Blocks

- eCQM, eCase Reporting, eCase Detection, and Clinical Decision Support share many common building blocks

- An integrated architecture with common and shared set of specifications for key components and delivered applications reduces friction and enhances interoperability

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Project Scope

- The purpose of this project is to convert CDC's gonorrhea treatment recommendations into an electronic clinical decision support (CDS) knowledge artifact that is:

  - conformant with current CDS interoperability standards

  - executable in standards based CDS engines

  - compliant with appropriate terminology standards

- The project was completed in 6 months and divided into three parts:

  - Part 1: Build logic flow diagram from 2015 STD guideline treatment and management recommendations

  - Part 2:Convert logic flow diagram to interoperable, standards-based representation using CQL Expression Language and FHIR Clinical Reasoning resources

  - Part 3: Implement and demonstrate the delivery of real-time clinical decision support using the Apervita computing platform
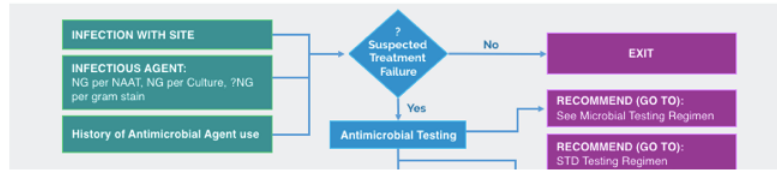
Methodology and Application Overview

L1 Started with paper CDS STI Guideline

L2 Converted Guideline to a logic flow diagram with CDC SME input

L3 Built standards-compliant CQL and FHIR Resources; specifying and encoding the logic with data model(s), terminology/code sets, value sets

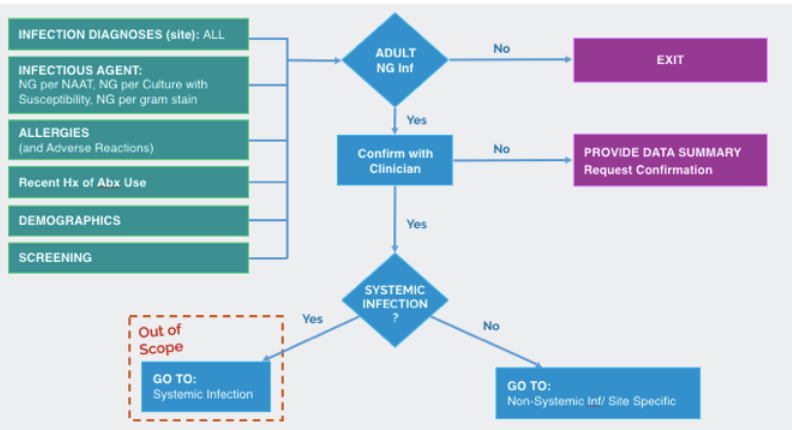**L4** Implemented real-time CDS in an execution environment (Apervita)

Boxwala AA, Rocha BH, Maviglia S, et al. A multi-layered framework for disseminating knowledge for computer-based decision support. Journal of the American Medical Informatics Association : JAMIA. 2011;18 Suppl 1:i132-i139. doi:10.1136/amiajnl-2011-000334.

Gonorrhea Logic Flow Diagrams

- *Non-Systemic Infection Expanded Scenarios*
  - Oropharyngeal NG Infection
    - Azithromycin Allergy
    - Cephalosporin Allergy
  - Urogenital & Anorectal NG Infection
    - Azithromycin Allergy
    - Cephalosporin Allergy
    - Pregnancy
  - Suspected Cephalosporin Treatment Failure
    - Test for Cure

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Going from L2 to L3 - Applying Current Informatics Standards to the Translation and Specification Process

| FHIR	HL7	NIH NLM	FHIR
FHIR QICore Data Profile	**CQL (Clinical Quality Language)**	**VSAC and custom Value Sets**	**FHIR STU3 PlanDefinition**
· Based upon Quality Information and Clinical Knowledge (QUICK) data model · Specializes in clinical decision support and quality measures · Designed to be highly interoperable	· CQL is designed to harmonize eCQMs and CDS · Provides for specification of interoperable expression logic · Both human-readable and machine-readable	· Define high-level concepts in terms of applicable codes from standard terminologies · Share standard definitions with eCQM specifications and measure developers	· FHIR STU3 resources are focused around reusability, performance, and data fidelity · PlanDefintion resource provides a template for recommendations and actions in treatment guidelines

L3 - Standards Used to Represent the Guidelines

- *Data Model Standards*
  - **FHIR QICore v1.6**
  - **FHIR Helpers v1.8.0**
- *Guideline Representation*
  - **Clinical Quality Language (CQL)**
  - **FHIR STU3 v1.8.0 Clinical Reasoning Resources**
- *Value Set Code Systems*
  - **LOINC**
  - **SNOMEDCT**
  - **RXNORM**
  - **NDF-RT**
- *Completely Standards-Based!*

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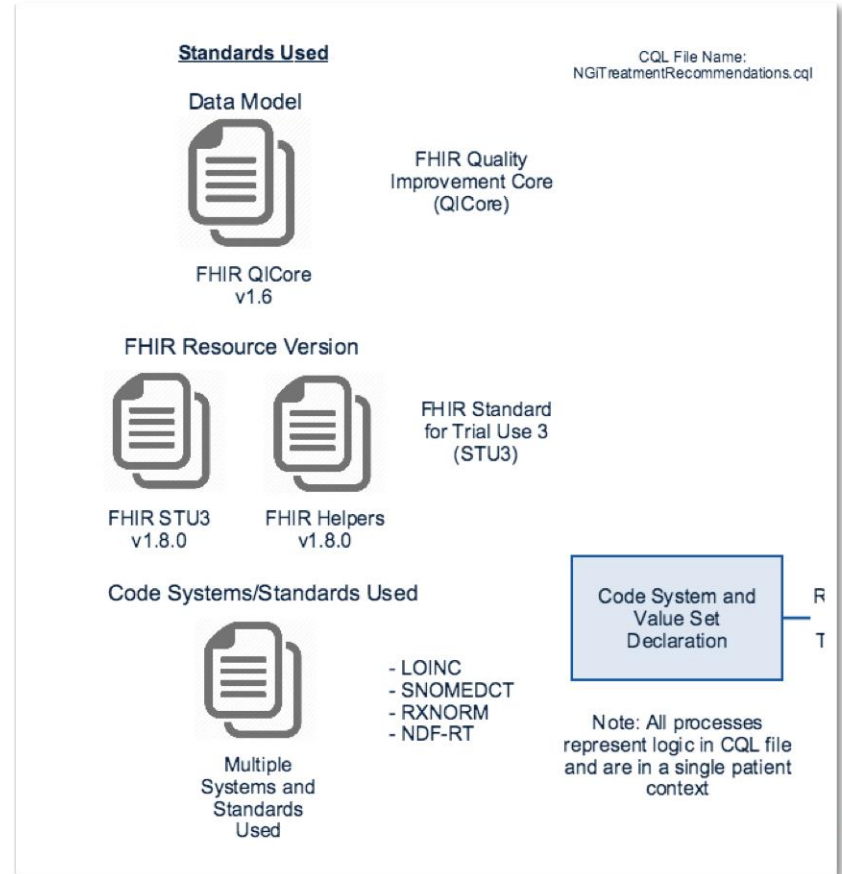
Going from L3 to L4 - Implementing the Standards Based CDS

Standards Based Implementation

HL7® FHIR®
- Standard Data Structure
- Customizable Careplans

NIH〉NLM
- Customizable Value Sets

CMS
CENTERS FOR MEDICARE & MEDICAID SERVICES
- Assess Clinical Scenarios

- HTML
- CDS Hooks
- EHR Integration

On-Demand Data Pull → Assess Qualification for Treatment → Treatment Guideline FHIR Resources → Customize Care plan → Render Care Plan

ΔPI Apervita ΔPI

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L4 - Implementation and Application Diagram

Cerner · Allscripts
EHR

Embedded Browser Window

CDS Hooks

Sapphire Application UI

SMART on FHIR App

Apervita Web Services - Execute Package and Retrieve Results

FHIR®©

Plan Definition

CDC STD Guideline Package

Individual Analytic

Individual Analytic

Other

Population CDS Analytic

Apervita Web Services - Retrieve Patient Data

Patient Database Accessed Via FHIR

FHIR®

Web Services Interactions - EHR and SMART on FHIR

Simulated patient data

P Peters, Paul · 00020557 Opened by Coombe , Rachel
_ □ ✕

Task   Edit   View   Patient   Chart   Links   Notifications   Navigation   Help

Patient List | Tear Off | Attach | Change | Suspend | Charge Entry | Exit | Calculator | AdHoc | Medication Administration | Depart | Patient Education | Result Copy | Related Records | Explorer Menu | | Links

Peters, Paul ✕   List | Recent ▾ | Name

Peters, Paul   DOB:1/19/1987   EMR:00020557   Fin #:000023935
** Allergies **   Age:30 years   Gender:Male   Loc:1 North ; ;

Menu   ‹ › ▾ 🏠   CDC Guidelines - Apervita   🖶 Print   ⟳ 0 minutes ago

| Apervita Clinical Decision Support | **Recommendations** | Evidence | About |

2015 CDC Guidelines for Sexually Transmitted Diseases

Treatment for NG Infections

| Standard Treatment Recommendation for Adult with New Untreated Gonorrhea |

| Evaluation for STD Co-infections in Adults with Gonorrhea |

| Treatment-associated Recommendations for New Gonorrhea |

Peters, Paul · 00020557 Opened by Coombe, Rachel

Task Edit View Patient Chart Links Notifications Navigation Help

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Peters, Paul ✕

Peters, Paul
** Allergies **

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DOB:1/19/1987   EMR:00020557   Fin #:000023935
          Age:30 years   Gender:Male   Loc:1 North ; ;

CDC Guidelines - Apervita   Print | 0 minutes ago

Apervita Clinical Decision Support   **Recommendations**   Evidence   About

2015 CDC Guidelines for Sexually Transmitted Diseases
Treatment for NG Infections

Standard Treatment Recommendation for Adult with New Untreated Gonorrhea

This patient has a new test result suggesting untreated gonorrhea and has no known allergies to the standard treatment regimen. Consider treatment with azithromycin 1g PO x1 dose and ceftriaxone 250mg IM x1 dose.

Propose order for azithromycin 1g PO x1 dose   [Submit Medication Request]

Propose order for ceftriaxone 250mg IM x1 dose   [Submit Medication Request]

Evaluation for STD Co-infections in Adults with Gonorrhea

If an adolescent or adult has evidence of gonorrhea and has not received simultaneous or subsequent evaluation for co-infection with chlamydia, syphilis, and HIV, then the missing tests should be performed.

Propose an order for a chlamydia test.   [Submit Procedure Request]

Propose an order for a syphilis test.   [Submit Procedure Request]

Propose an order for an HIV test.   [Submit Procedure Request]

Treatment-associated Recommendations for New Gonorrhea

If this patient has a new test result suggesting gonorrhea. then the patient's sexual partners during the last 60 days should receive evaluation and presumptive treatment for gonorrhea, the patient should be retested for gonorrhea 3 months after treatment, and patient

CMTDEV | RC019210 | June 26, 2012 | 9:51 AM CDT

Contrary, Mary 0020557 Opened by Coombe , Rachel

Task   Edit   View   Patient   Chart   Links   Notifications   Navigation   Help

Patient List | Tear Off | Attach | Change | Suspend | Charge Entry | Exit | Calculator | AdHoc | Medication Administration | Depart | Patient Education | Result Copy | Related Records | Explorer Menu | Links

Contrary, Mary

Contrary, Mary
** Allergies **

DOB:1/19/1990   EMR:00020557   Fin #:000023935
          Age:27 years   Gender:Female   Loc:1 North ; ;

List   Recent   Name

CDC Guidelines - Apervita   Print   0 minutes ago

Apervita Clinical Decision Support   **Recommendations**   Evidence   About

2015 CDC Guidelines for Sexually Transmitted Diseases
Treatment for NG Infections

Recommended Treatment for Adult with New Untreated Urogenital/Anorectal NG Infection and Allergy to Azithromycin

Recommendations for Recurrent Gonorrhea When Cephalosporin Treatment Failure Is Suspected

Evaluation for STD Co-infections in Adults with Gonorrhea

Treatment-associated Recommendations for New Gonorrhea

Contrary, Mary 0020557 Opened by Coombe , Rachel

Task   Edit   View   Patient   Chart   Links   Notifications   Navigation   Help

Patient List | Tear Off | Attach | Change | Suspend | Charge Entry | Exit | Calculator | AdHoc | Medication Administration | Depart | Patient Education | Result Copy | Related Records | Explorer Menu | Links

Contrary, Mary

Contrary, Mary			
** Allergies **	DOB:1/19/1990	EMR:00020557	Fin #:000023935
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CDC Guidelines - Apervita

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Apervita Clinical Decision Support   Recommendations   Evidence   About

Treatment for NG Infections

Recommended Treatment for Adult with New Untreated Urogenital/Anorectal NG Infection and Allergy to Azithromycin

Recommendations for Recurrent Gonorrhea When Cephalosporin Treatment Failure Is Suspected

This patient appears to have recurrent gonorrhea after prior treatment with a cephalosporin. If cephalosporin treatment failure is suspected, consider microbial testing (C&S for N. gonorrhoeae, if not done), and consider testing for eradication and cure with both a NAAT and C&S for N. gonorrhoeae 14 days after re-treatment.

Propose an order for a culture before re-treatment in the setting of recurrent gonorrhea with suspected cephalosporin treatment failure.   [Submit Procedure Request]

Propose an order for a test of antibiotic susceptibilities for any Neisseria gonorrhoeae organisms that may be identified by a culture test obtained in the setting of recurrent gonorrhea with suspected cephalosporin treatment failure.   [Submit Procedure Request]

Propose an order for a NAAT to detect the persistent presence of Neisseria gonorrhoeae 14 days after treatment in the setting of suspected cephalosporin treatment failure.   [Submit Procedure Request]

Propose an order for a culture to detect the persistent presence of Neisseria gonorrhoeae 14 days after treatment in the setting of suspected cephalosporin treatment failure.   [Submit Procedure Request]

Propose an order for a test of antibiotic susceptibilities for any Neisseria gonorrhoeae organisms that may be identified by a culture test obtained 14 days after re-treatment in the setting of suspected cephalosporin treatment failure.   [Submit Procedure Request]

CMTDEV RC019210 June 26, 2012 9:51 AM CDT

Sapphire

Ms. Mary Contrary

DOB :1989-10-29
Age : 27
Gender :Female

Address :
168 Florence Street
Springfield, IL, , USA

Contact :
☎ Mobile : 708-555-1212
☎ Home : 708-555-6666

Recent results

Test	DateTime	Result
Hemoglobin [Mass/volume] in Blood	2017-05-03 01:02 AM	12.3g/dL Final
Neisseria gonorrhoeae rRNA [Presence] in Vaginal fluid by Probe and target amplification method	2016-09-11 07:00 PM	POS Final
Chlamydia trachomatis [Presence] in Urine sediment by Organism specific culture	2016-08-02 04:00 PM	POS Final
Neisseria gonorrhoeae Ag [Presence] in Unspecified specimen	2016-08-02 04:00 PM	POS Final

CDS Hook

Evaluation for STD Co-Infections in Adults with Gonorrhea

Treatment-associated Recommendations for New Gonorrhea

Recommended Treatment for Adult with New Untreated Urogenital/Anorectal NG Infection and Allergy to Azithromycin

Recommendations for Recurrent Gonorrhea When Cephalosporin Treatment Failure Is Suspected

This patient appears to have recurrent gonorrhea after prior treatment with a cephalosporin. If cephalosporin treatment failure is suspected, consider microbial testing (C&S for N. gonorrhoeae, if

Related medications

Medication	Start Date	End Date
Ceftriaxone 250 MG Injection 250 mg, intramuscular, once	2016-08-01 12:30 PM	2016-08-01 12:30 PM
Doxycycline Monohydrate 100 MG Oral Capsule 100 mg, By Mouth, two times a day	2016-08-01 01:30 PM	2016-08-08 12:00 AM

Related allergies

Substance		Status	Recorded
Azithromycin	!	confirmed	2011-07-13 07:00 AM

Related diagnoses

Problems	Onset
Gonococcal infection, unspecified (ICD10CM: A54.9)	2017-03-01

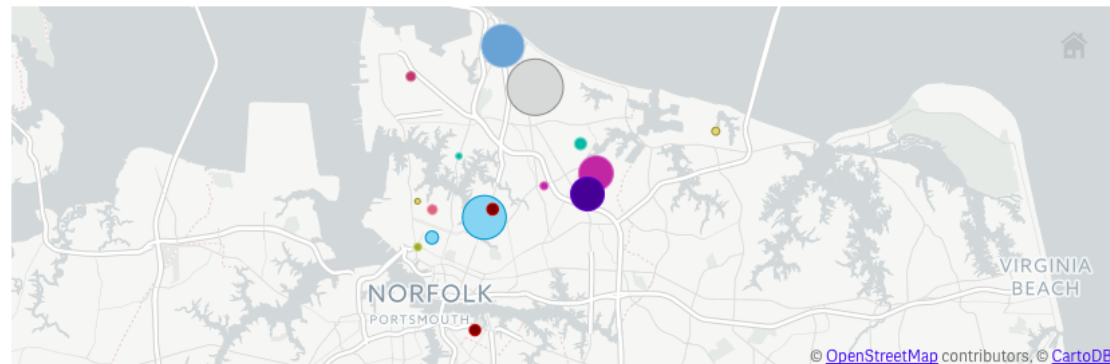## Resources

MedlinePlus
Trusted Health Information for You

Resources for the patient

- Gonorrhea also called: The clap
- Understanding Gonorrhea tests

STD Cases at Sacred Heart Norfolk Clinics, 2017 YTD

© OpenStreetMap contributors, © CartoDB

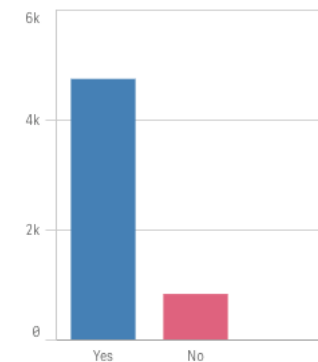| SH Gonorrhea Cases	SH Gonorrhea Follow Ups	STD Case Count in Norfolk, VA
558	168	15,313

STD 🔍	Sacred Heart Case Count	Norfolk Case Count
Totals	5567	15313
HPV	3637	10031
Chlamydia	843	2311
Gonorrhea	558	1552
Trichomoniasis	290	741

SH NG Guideline Followed

Share of STD Cases

SH 36.4 %
Other 63.6 %

STD Case Distribution - Sacred Heart

HSV-2
Trichomoniasis
Gonorrhea 10.1 %
Chlamydia 15.1 %
HPV 65.5 %

STD Case Distribution - National

Gonorrhea
HSV-2
Trichomoniasis
Chlamydia 14.5 %
HPV 71.6 %
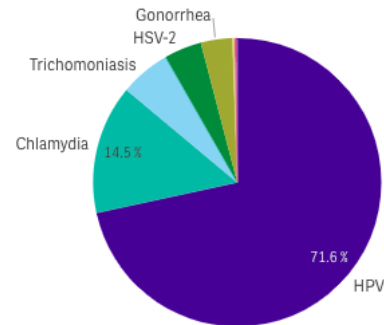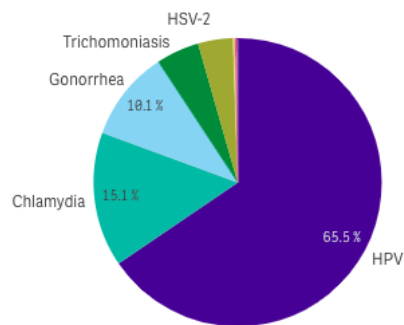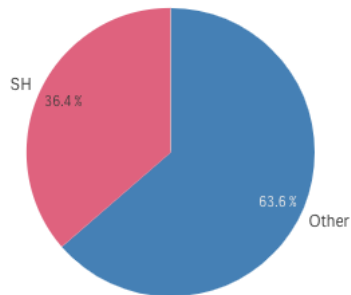
Lessons Learned

- Broadly accepted standards are in place today to accomplish representation and delivery of interoperable Guidelines and Clinical Decision Support

- Going from paper Guidelines to logic flow diagram (L1 to L2) was not a straight forward translation and required domain expertise and input from clinical SMEs

- Going from L2 to L3 also required significant clinical informatics expertise to identify Value Sets and Plan Definitions for treatment recommendations

- Information required to drive clinical decision choices may not exist, proxies are needed for true data enablement

Acknowledgements

- Ninad Mishra, MS, MD
- Bob Kirkcaldy, MD, MPH
- Emily Weston, MPH

- Jim Jellison, MPH
- Michael DeMayo, MPH
- Natalie Viator, MPH

- Aziz Boxwala, MD, PhD, FACMI
- Randolph Barrows, MD
- Lana Tsurikova, MSc, MA

- Blackford Middleton, MD, MPH, MSc
- Matthew Burton, MD
- SiSi Shen, MBA
- Andy Schriever
- Tony Thai, MBA
- Kenji Wong

Discussion / Questions & Answers

- Thank you!

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