ACT COVID-19 Response:
Using the ACT Network to Gain Insight Into COVID-19

May 5, 2020
Health Informatics is the science of how to use data, information, and knowledge to improve human health, including the execution of scientific research, the delivery of health care services, and the promotion of public health. AMIA is the multi-disciplinary, inter-professional home for 5,400+ health informatics experts.
Working Groups of AMIA

Biomedical Imaging Informatics
Clinical Decision Support
Clinical Information Systems
Clinical Research Informatics
Consumer and Pervasive Health Informatics
Dental Informatics
Education
Evaluation
Bioinformatics
Ethical, Legal and Social Issues
Genomics and Translational Global Health Informatics
People and Organizational Issues

Intensive Care Informatics
Knowledge Discovery and Data Mining
Knowledge Representation and Semantics
Nursing Informatics
Open Source Student
Pharmacoinformatics
Primary Care Informatics
Public Health Informatics
Regional Informatics Action
Visual Analytics
Natural Language Processing
The Globe of Health Informatics & COVID-19

- Analysis of Coronavirus
- Development of Therapeutics and symptom identification
- Treatment of patients via EHRs & Information Exchange
- Tools for contact tracing and for study of transmission

- DNA
- Small Molecules
- Disease
- Patient
- Practice
- Population
- Global

- 10^-9
- 10^-6
- 10^-3
- 10^0
- 10^3
- 10^6
- 10^9

- TBI
- CRI
- Public Health
- Clinical
- Consumer Health
To highlight how our members and the broader informatics community is addressing this global pandemic we are launching the AMIA COVID-19 Webinar Series.

We will look at the pandemic through a health informatics lens and is designed to share informatics responses to the COVID-19 pandemic. Panelists will share their specific domain expertise, including clinical informatics, public health informatics, translational bioinformatics, clinical research informatics, and consumer health informatics.

We will also have special emphasis webinars covering topics related to global health, telemedicine, and public policy during the COVID-19 pandemic. These webinars are open to all at no cost.
Several additional webinars are being planned to highlight members of AMIA and the wider informatics community

Visit AMIA.org/COVID19
ACT COVID-19 Response
Using the ACT Network to Gain Insight Into COVID-19
AMIA COVID-19 Webinar Series, May 5, 2020
Panelists

Lee Nadler, MD
Dean of Clinical and Translational Research at Harvard Medical School
Principal Investigator, Harvard Catalyst
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Shawn Murphy, MD, PhD
Chief Research Information Officer at Partners HealthCare
Professor of Biomedical Informatics at Harvard Medical School

Shyam Visweswaran, MD, PhD
Director of Clinical Informatics, Department of Biomedical Informatics University of Pittsburg
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Douglas MacFadden
Senior Chief Informatics Officer
Harvard Catalyst
ACT Network: Structure, Scope, Usage
ACT Goals and Funding

• Funded by NCATS to support cohort discovery for multicenter clinical trials
  • Study feasibility
  • Identifying sites with patient cohorts
• Local identification of eligible patients using i2b2 plugins
• Support broad range of clinical & translational research
• [http://www.actnetwork.us/national](http://www.actnetwork.us/national)
ACT Structure

Guidance, sets direction

PI Group

Executive Committee

Work Groups, Network Operations

ACT Hubs/Institutions

Reporting, compliance
ACT Work Groups

- **Governance**
  - Bob Toto, Dipti Ranganathan

- **Regulatory**
  - Gary Firestein, Eric Mah, Karen Allen

- **Technology**
  - Doug MacFadden, Nick Anderson, Shawn Murphy, Griffin Weber, Russ Waitman

- **Data Harmonization**
  - Shyam Visweswaran, Michele Morris

- **Dissemination & Evaluation**
  - Elaine Morrato, Harold Pincus
The ACT Network

Connected to ACT:
Boston University
Children’s National
Columbia University
Duke University
Emory Univ./Morehouse Univ.
Harvard University
Indiana University
Johns Hopkins University
Mayo Clinic
Medical College of Wisc.
Medical Univ. of South Carolina
New York University
Northwestern University
Ohio State University
Oregon Health & Service University
Penn State
Stanford University
U of Alabama at Birmingham
University of Arkansas
University of California, Davis
University of California, Irvine
University of California, Los Angeles
University of California, San Diego
University of California, San Francisco
University of Cincinnati
U of Colo/Children's Hops. Colorado
University of Florida
University of Illinois-Chicago
University of Kansas
University of Kentucky
University of Minnesota
University of North Carolina at Chapel Hill
University of Pittsburgh
University of Southern California
University of Washington
UT Health Houston
UT Health San Antonio
UT Southwestern
Vanderbilt University Medical Cent
Virginia Commonwealth University
Washington University in St. Louis
Weill Cornell Medicine

Staging for ACT:
Case Western University
Dartmouth College
Scripps Research/Scripps Health
Tufts University
University at Buffalo
University of Massachusetts
University of Miami
University of Michigan
University of New Mexico
University of Rochester
University of Texas Medical Branch
University of Utah
University of Virginia
U of Wisconsin-Madison
Wake Forest University

In use by almost 5,000 end users at 26 institutions

More than 440,000 queriable data elements

Over 130 million unique patients currently available to query across the network

Participation by 57 CTSAs

42 data contributing nodes on the production network
Growing ACT Network Usage

Total ACT Queries by Year

*Year to date through October plus projected through year-end
# ACT Network Tiers

## Production Network
- End user access
- 40+ Nodes
- 24/7 operations
- Formal helpdesk
- Maximized availability
- Minimized variability
- Data Steward at site for monitoring query behavior
- Data refresh monthly

## Stage Network
- No end user access
- For new sites joining ACT network and production sites to have an environment to improve or validate processes
- Variable # of nodes attached at any given time
- Data refresh to suit site testing needs

## Test Network
- No end user access
- Test new Versions of Technical Components
- 5+ Nodes
- Data refresh to suit needs
Typical ACT Site Technology Components:
- SHRINE
- i2b2
- Ontology
ACT COVID-19 Response: Overview
ACT COVID-19 Response

• Leverage what we already have to fight the COVID-19 pandemic
  • 7 years of working together to form the ACT Network
  • Governance and network agreements in place at 40+ sites
  • Strong CTSA relationships and goodwill to support a shared tool
  • Infrastructure already allocated and technology already installed

• Allows ACT to create a COVID-19 research network
  • Rapidly
  • Low cost
  • Using familiar technologies and processes
• **Team Formation:** Agree to create a network for COVID-19 research; negotiate data refresh scope and frequency based on participating site feedback

• **Network Expansion:** Recruit sites to join the COVID-19 network

• **Ontology Augmentation:** Add new COVID-19 coding terms to the existing ACT ontology, support sites in mapping to these terms

• **Data Validation:** Check site data load and mapping with manual and scripted testing strategies, deploying each as they are ready

• **Research Support:** Enable a small group of researchers across the network sites to validate/provide feedback for the capabilities of the network
ACT COVID-19 Response

COVID-19 Network

- Phased end user access
- 9+ nodes and growing
- Data Steward for monitoring query behavior
- Data refresh at least twice a week
- Augmented ontology for COVID research
- Revised network agreement; publication review process for researchers
- Additional data quality efforts
  - Researcher initiated, ad hoc validation
  - Periodic script runs and central analysis of output to check for data or ETL aberrations
  - Twice-weekly central data load verification
ACT COVID-19 Network Commitments

• COVID-19 patient data refresh twice weekly (at a minimum) from the EHR; some as often as daily
• Iterative ontology development, deployment, and data mapping to support COVID-19 research as it evolves
• Optimization of local processes to speed this effort and reduce downtime on the network
• Responsiveness to researcher queries and ad hoc troubleshooting

We are grateful for the rapid response to this emerging need at a time of increased local demand for informatics and IT support
ACT COVID-19 Network Snapshot

- **Size and Scope**
  - 9 network sites
  - More than 30M lives
- **As of May 1:**
  - Over 15,000 patients that have tested positive for COVID-19
  - Over 87,000 patients that have tested negative for COVID-19

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<table>
<thead>
<tr>
<th>Site Name on Test Network</th>
<th>Institution Name and Location</th>
<th>Limits for patient data load</th>
<th>Frequency for COVID-19 research population</th>
<th>Frequency for additional patients beyond COVID-19 research population</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIDMC</td>
<td>Beth Israel Deaconess Medical Center, Boston MA</td>
<td>N/A; All patient data loaded</td>
<td>Once per day</td>
<td>TBD</td>
</tr>
<tr>
<td>UAB</td>
<td>Univ of Alabama, Birmingham AL</td>
<td></td>
<td>Twice per week</td>
<td>TBD</td>
</tr>
<tr>
<td>USC Keck</td>
<td>Univ of Southern California Keck Medicine, Los Angeles CA</td>
<td></td>
<td>Once per week</td>
<td></td>
</tr>
<tr>
<td>UCSD</td>
<td>University of California, San Diego CA</td>
<td></td>
<td>Once per day</td>
<td>Once per week</td>
</tr>
<tr>
<td>Kansas U</td>
<td>Kansas Univ Medical Center, Kansas City, KS</td>
<td>COVID plus additional (based on COVID phenotyping inclusion-criteria document* + PCORnet Inclusion criteria + 10 to 200 random patients)</td>
<td>Three times per week</td>
<td></td>
</tr>
<tr>
<td>UPitt</td>
<td>Univ of Pittsburgh, Pittsburgh, PA</td>
<td>COVID plus additional (COVID tested Patients + 6000 random patients)</td>
<td>Twice per week</td>
<td></td>
</tr>
<tr>
<td>Partners</td>
<td>Partners HealthCare, Boston MA</td>
<td>COVID only (patients with a COVID lab test)</td>
<td>Once per day</td>
<td>N/A</td>
</tr>
<tr>
<td>UCLA</td>
<td>Univ of California, Los Angeles CA</td>
<td>COVID only (based on COVID phenotyping inclusion-criteria document**))</td>
<td>Once per weekday</td>
<td>N/A</td>
</tr>
<tr>
<td>UTSW</td>
<td>UT Southwestern Medical Center, Dallas TX</td>
<td>COVID only (patients with a COVID lab test or a diagnosis code from the PCORnet**)</td>
<td>Once per day</td>
<td>Once per week</td>
</tr>
</tbody>
</table>
ACT COVID-19 Response: Ontology Augmentation
ACT Ontology Augmentation

- ACT COVID-19 Phenotype
- ACT Ontology with COVID-19 Augmentation
- Derived terms in the Ontology
- Prioritization of derived terms
ACT COVID-19 Phenotype

- ACT COVID-19 phenotype:
  - Either, include all patients available at the participating node (for nodes that can refresh the entire i2b2 data mart frequently)
  - Or, only COVID-19 patients defined by selection criteria (for nodes that can refresh only COVID-19 patients frequently in the i2b2 data mart)
- The definition of the phenotype will be iteratively expanded as new ICD-10, CPT-4 and LOINC codes for COVID-19 are added
- GitHub: https://github.com/shyamvis/covid-phenotyping
ACT COVID-19 Phenotype

ICD-10-CM

• B97.29 - Other coronavirus as the cause of diseases classified elsewhere (recorded on or after 01/01/2020)
• B97.21 - SARS-associated coronavirus as the cause of diseases classified elsewhere (recorded on or after 01/01/2020)
• U07.1 - 2019-nCoV acute respiratory disease

CPT-4

• 87635 – Infectious agent detection by nucleic acid (DNA or RNA)

HCPCS

• U0001 – Coronavirus testing using the Centers for Disease Control and Prevention (CDC) 2019 Novel Coronavirus Real Time RT-PCR Diagnostic Test Panel
• U0002 – Validated non-CDC laboratory tests for SARS-CoV-2/2019-nCoV (COVID-19)

LOINC (orders)

• 94531-1
• 94306-8
• 94503-0
• 94504-8

LOINC (results)

• 94500-6
• 94533-7
• 94534-5
• 94532-9
• 94502-2
• 94309-2
• 94316-7
• 94307-6
• 94308-4

LOINC (results)

• 94510-5
• 94311-8
• 94312-6
• 94315-9
• 94509-7
• 94314-2
• 94511-3
• 94310-0
• 94313-4
• 94507-1
• 94505-5
• 94508-9
• 94506-3
• 94547-7
ACT Ontology with COVID-19 Augmentation

ACT COVID-19 Ontology

ACT Ontology
ACT COVID-19 Ontology

- COVID-19 Ontology includes:
  - **Emerging** COVID-19 ICD-10, CPT, HCPCS, LOINC codes that are not included in the standard ACT ontology
  - **Existing** ICD-10, CPT, medication codes for convenience
  - **Derived terms** that are of particular interest in COVID-19 research

- The ontology is refined based on emerging needs and is rapidly deployed

- Currently version 2 is deployed, and next version is in development
ACT COVID-19 Ontology
ACT COVID-19 Ontology

- Derived terms
- Harmonized terms
- Emerging codes
- Existing codes
## Prioritization of Derived Terms

<table>
<thead>
<tr>
<th>Priority</th>
<th>c_name</th>
<th>c_basecode</th>
<th>comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Known Deceased</td>
<td>DEM</td>
<td>VITAL STATUS:D</td>
</tr>
<tr>
<td>3</td>
<td>Extracorporeal membrane oxygenation (ECMO)</td>
<td>UMLS:C0015357</td>
<td>The State is TRUE between 7 days before the COV</td>
</tr>
<tr>
<td>4</td>
<td>Intubation</td>
<td>UMLS:C0021025</td>
<td>The State is TRUE between 7 days before the COV</td>
</tr>
<tr>
<td>5</td>
<td>Mechanical Ventilation</td>
<td>UMLS:C0199470</td>
<td>The State is TRUE between 7 days before the COV</td>
</tr>
<tr>
<td>6</td>
<td>Supplemental Oxygen</td>
<td>UMLS:C4534306</td>
<td>The State is TRUE between 7 days before the COV</td>
</tr>
<tr>
<td>7</td>
<td>Hospital Inpatient Services</td>
<td>CPT4:1013659</td>
<td>The State is TRUE between 7 days before the COV</td>
</tr>
<tr>
<td>8</td>
<td>Emergency Department Services</td>
<td>CPT4:1013711</td>
<td>The State is TRUE between 7 days before the COV</td>
</tr>
<tr>
<td>9</td>
<td>Critical Care Services</td>
<td>CPT4:1013729</td>
<td>The State is TRUE between 7 days before the COV</td>
</tr>
<tr>
<td>10</td>
<td>Inpatient (Critical Care)</td>
<td>UMLS:C1547136</td>
<td>The State is TRUE between 7 days before the COV</td>
</tr>
<tr>
<td>11</td>
<td>Inpatient (Routine)</td>
<td>UMLS:C1547137</td>
<td>The State is TRUE between 7 days before the COV</td>
</tr>
<tr>
<td>12</td>
<td>Emergency</td>
<td>UMLS:C1561585</td>
<td>The State is TRUE between 7 days before the COV</td>
</tr>
<tr>
<td>13</td>
<td>Lymphocytopenia</td>
<td>ICD10CM:D72.810</td>
<td>The State is TRUE between 7 days before the COV</td>
</tr>
<tr>
<td>14</td>
<td>Pneumonia</td>
<td>ICD10CM:J18.9</td>
<td>The State is TRUE between 7 days before the COV</td>
</tr>
<tr>
<td>15</td>
<td>Acute Respiratory Distress Syndrome</td>
<td>ICD10CM:J80</td>
<td>The State is TRUE between 7 days before the COV</td>
</tr>
<tr>
<td>16</td>
<td>Ventilator Associated Pneumonia</td>
<td>ICD10CM:J95.851</td>
<td>The State is TRUE between 7 days before the COV</td>
</tr>
<tr>
<td>17</td>
<td>Biofire PCR Panel Titre</td>
<td>ACT</td>
<td>DERIVED:BIOFIRE</td>
</tr>
<tr>
<td>18</td>
<td>Initial Hospital Inpatient Care Services</td>
<td>CPT4:1013660</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>New or Established Patient Initial Hospital Inpatient Care Services</td>
<td>CPT4:1013661</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Subsequent Hospital Care Services</td>
<td>CPT4:1013668</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Observation or Inpatient Care Services (Including Admission and Discharge Services)</td>
<td>CPT4:1013675</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Hospital Discharge Services</td>
<td>CPT4:1013682</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Hospital discharge day management</td>
<td>CPT4:1013683</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>New or Established Patient Emergency Department Services</td>
<td>CPT4:1013712</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Other Emergency Department Services</td>
<td>CPT4:1013723</td>
<td></td>
</tr>
</tbody>
</table>
ACT COVID-19 Response: Current & Near-Term Capabilities
AIMS for ACT COVID-19

• Create a COVID-19 Centric Portal that allows general institutional use with proper agreements in place where patient cohorts can be studied, outcomes measured, and novel questions asked to:

• Enable the efficient and collaborative use of EHR data to answer specific scientific questions that arise throughout the Pandemic using data of proven accuracy, possibly leading to:

• Use the COVID-19 Portal to perform feasibility assessments to guide clinical trials
There are many ways that a COVID+ Test is reported
A COVID+ Test can be made into a single fact.
A COVID-19 Test can be made into a single fact.
Aggregate POS and NEG Facts are added
New Query Can be Built from new Ontology that will fully run in Local Database

• COVID+
  • More than 14 days go by

• COVID-
  • More than 14 days go by

• COVID+

WITH covid_results AS(
  SELECT DISTINCT
    patient_num,
    LAG(f.update_date) OVER (PARTITION BY patient_num
      ORDER BY f.update_date) previous_result_date,
    LAG(substring(f.concept_cd, charindex(' ', f.concept_cd) +1, 8)) OVER (PARTITION BY patient_num
      ORDER BY f.update_date) previous_result
    ,f.update_date result_date,
    substring(f.concept_cd, charindex(' ', f.concept_cd) +1, 8) test_result,
    LEAD(f.update_date) OVER (PARTITION BY patient_num
      ORDER BY f.update_date) post_result_date,
    LEAD(substring(f.concept_cd, charindex(' ', f.concept_cd) +1, 8)) OVER (PARTITION BY patient_num
      ORDER BY f.update_date) post_result
  --get all COVID Labs results that are positive or negative
  FROM observation_fact f inner join concept_dimension c
  on c.concept_cd = f.concept_cd
  where (concept_path like 'ACT\UMLS_C0031437\SNOMED_3947185011\UMLS_C0022885\UMLS_C1335447\%') --any positive
    or concept_path like 'ACT\UMLS_C0031437\SNOMED_3947185011\UMLS_C0022885\UMLS_C1334932\%' --any negative
)
ACT Teams focus on creating new Facts
Many new Queries Can be Distributed and Run Using the New Ontology

- COVID+
  - Intubation and death
- Was this predisposed by:
  - Prior medications
  - Prior Conditions
- COVID+
  - Oxygen
  - What was PaO2 level that led to:
    - Intubation
  - Followed by:
    - Death
- COVID-
  - < 2 days
  - Becomes COVID+
    - Test sensitivity
- COVID+
  - Gender
  - Timing and prevalence of:
    - Oxygenation
    - Mechanical Ventilation
    - Death
Uniqueness of ACT Analytics

• Highly dynamic system to ask new questions
• Respects patient and institutional privacy with distributed queries and compilation of aggregate results
• Local data expertise can be used to build facts guided by ontology item definitions
• Translates directly to data that can be leveraged for clinical trials
ACT COVID-19 Response: Landscape
Other Networks – 4CE

- i2b2 Academic Users Group
  Isaac Kohane
- Aggregate data from i2b2 sites
  - 96 hospitals
- Website - https://covidclinical.net/
- Product
  - Preprint in medRxiv on 4/30
Other Networks - ODHSI

• I2b2 Academic Users Group
• Aggregate data from OMOP sites
  • 4 hospitals
• Website - https://www.ohdsi.org/covid-19-updates/
• Product
  • Preprint in medRxiv on 4/25
• OMOP Data Model – 4 sites
  • US (Columbia University Irving Medical Center [CUIMC], Stanford Medicine Research data Repository [STARR-OMOP], and the Department of Veterans Affairs [VA OMOP]) and Health Insurance Review & Assessment [HIRA] of South Korea
Other Networks – COMBATCOVID

- NYU Langone - Consortium for Multisite Biomedical Analytics and Trials on COVID-19
  - Silvia Curado
- Multi-Data Models - 14 sites
- Website – none
- Product
  - Local Hospital produced NEJM Paper
Other Networks

• National COVID Cohort Collaborative (https://covid.cd2h.org/N3C)
  • ACT will play a role in the N3C effort, as discussed in the AMIA COVID webinar series instance on April 13, 2020

• Covid-19 Host Genomics Initiative (https://www.covid19hg.org/)
ACT COVID-19 Response: Researcher Access
• First Phase Access - Now
  • Selected researchers from 9 COVID-19 Network participating sites
  • Earliest researchers will be asked to work with us in the course of their research
    • Refining and improving the ACT COVID-19 ontology to enable better and more meaningful research
    • Identifying potential data quality issues for investigation or remediation
    • Agree to take steps to ensure responsible dissemination of information at this critical time in public health

• Later Phases of Access
  • Additional researchers from COVID-19 Network participating sites following successful first phase
  • Additional researchers from other ACT participating sites following successful COVID-19 Network participant access

• What if my institution is not part of ACT?
Thank You

Questions?
Audience Q&A
AMIA’s 2020 Virtual Clinical Informatics Conference Webpage: https://www.amia.org/cic2020

Clinical and Health Informatics Practitioners… CIC is YOUR conference.