### RADx Tech and ATP Programs

<table>
<thead>
<tr>
<th>500</th>
<th>MILLION TESTS PRODUCED</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>FDA AUTHORIZED TESTS</td>
</tr>
<tr>
<td>1st</td>
<td>OVER-THE-COUNTER TEST FOR USE AT HOME</td>
</tr>
<tr>
<td>&gt;100</td>
<td>ORGANIZATIONS SUPPORTED BY RADx TECH/ATP</td>
</tr>
</tbody>
</table>

**RADx Tech NIH Leads:** Jill Heemskerk, Todd Merchak, Tiffani Lash, Mike Wolfson, Doug Sheeley, Bill Heetderks, Felicia Qashu, Tony Kirilusha, Mark Snyder, Andrew Weitz, Krishna Juluru, Taylor Gilliland, Rachael Fleurence, Matt McMahon, Jennifer Jackson, Ray MacDougall, Patty Wiley, Chris Cooper, David George
April 24, 2020: $1.5B to NIH
$500 Million to NIBIB

**RADx: Unexpected Opportunity**

**NIH Office of the Director**

Francis Collins  Rachael Fleurance  Larry Tabak  Tara Schwetz

1) Expand COVID-19 Testing Technologies: Number, Type and Access
2) Optimize Performance: Technologic and Operational; Match Community Needs

**RADx Tech – $500M**

Highly competitive, rapid three-phase challenge to identify the best candidates for at-home or point-of-care tests for COVID-19

**RADx Advanced Technology Program (RADx-ATP) – $230M**

Rapid scale-up of advanced technologies to increase rapidity and enhance and validate throughput – create ultra-high throughput machines and facilities

**RADx Radical (RADx-Rad) – $200M**

Develop and advance novel, non-traditional approaches or new applications of existing approaches for testing

**RADx Underserved Populations (RADx-UP) – $500M**

Interlinked community-based demonstration projects focused on implementation strategies to enable and enhance testing of COVID-19 in vulnerable populations

>12 NIH Institutes, Centers, and Offices

**National Institute of Biomedical Imaging and Bioengineering (NIBIB)**

Jill Heemskerk  Bruce Tromberg

**$307 M Partnership**

[https://www.nih.gov/research-training/medical-research-initiatives/radx](https://www.nih.gov/research-training/medical-research-initiatives/radx)
RADx: Leverage Existing Network (POCTRN)

NIBIB Point of Care Tech Network: NHLBI, NIAID, NCCIH, FIC, OBSSR, OAR, ODP

Established 2007, Expanded 2020: >900 RADx experts & contributors
(USG, Academia, Industry, NFP)

https://www.poctrn.org

GaTech/Emory
- Engineering
- Design/Prototype
- Clinical Validation
- Biobank Samples
- In-Home Validation

Johns Hopkins
- Public Health/STD
- Global Health
- Clinical Validation
- Biobank samples
- Validation in LMICs

Northwestern
- HIV/AIDS
- Engineering
- Global Health
- Clinical Validation
- Validation in LMICs

CIMIT/MGH
- Coordinating Center
- Collaboration/Management Platform
- Business/Commercialization

UMass
- Heart, lung, blood
- Engineering
- Clinical Validation
- Biobank samples
- Clinical Trials
- Business/Commercialization

Operations:
- Review & Fund
- Test & Validate
- Expert Guidance

Validation Core
- >70 projects complete,
  >3000 participants

Clinical Studies Core
- Standard Trial Design, Digital Health Platform,
  Single IRB, Center Network

Deployment Core
- Supply chain, Manufacturing,
  User Community,
  whenotest.org
  ASU testing common
  Project N95
RADx Tech Process: Innovation Funnel

NATIONAL CALL FOR INNOVATIVE TECHNOLOGIES

PHASE 0: “Shark Tank”-Like Rapid Selection Process

PHASE 1: Validation and Risk Review

PHASE 2: Clinical Tests, Regulatory Approval, and Scaling Up

END OF SUMMER/FALL 2020

~3000 Applications Started

Rolling submission open April 29

5-6 Months

Funnel 1 May 2020: 3.5 mos.
Funnel 2 June 2021: 1 month

Projects in each Phase

Small business
Academic
Start-up
Mid-size business
Large business
Other
Non-Profit Lab/CIO

Innovation, entrepreneur community

824 179 47 44 ~$660M

Validation, Clinical Testing, Regulatory, Manufacturing, Distribution
RADx Tech Impact: Capacity thru October 2021

Cumulative EUA Authorized Tests by Month

Major Milestones

- 1.14 billion capacity thru October 2021
- ~5.1 M tests and products/day October 2021
- 35 EUAs; 1st OTC EUA, 4 “at home”

~$1.1 Billion: Special Congress Authorization (~$600M in Phase 2)

~1.3 Billion: Private Capital Raised

Impact: National Policy

Work (OSHA): vaccine, weekly testing
Entertainment: show negative test
School: regular testing
Procurement: $3B OTC/POC tests, DPA
Retailers: sell OTC at cost, Medicaid reimbursement
Community: distribute OTC to high SVI regions
Pharmacy: Expand free POC access

When To Test
https://whentotest.org
SAY YES! COVID TEST
https://sayyescovidtest.org

September 11, 2021

Health
How at-home coronavirus testing is becoming part of Biden’s plan for managing the pandemic

September 9, 2021

RADx tests
SYCT program

https://whentotest.org
https://sayyescovidtest.org

By Derek Hawkins and Fenit Nirappil

A Pitt County Health Department worker passes out at-home coronavirus test kits April 21 in Greenville, N.C. (Melissa Sue Gerrits for The Washington Post)
STOP THE SPREAD OF COVID-19

FOR INDIVIDUALS

START CALCULATOR

Don’t spread COVID-19 in your community!
The When To Test Calculator for Individuals helps you decide whether you should consider getting tested.

FOR ORGANIZATIONS

START CALCULATOR

CDC guidelines provide a COVID-19 testing approach that applies to the population nationwide. The When To Test Calculator is designed to offer a more granular testing strategy for individual organizations based upon their unique mitigation strategies, level of compliance, and community prevalence.

Vaccination rates
R0 altered for Delta
Pooling guidance
K-12 playbook (CDC)
Individual risk calculator
Link purchase, guidance

>50,000 users
RADx Tech Impact: sayyescovidtest.org

This report reflects tests purchased directly by NIH to support specified projects. Tests purchased separately by awardees are not shown.

6.9M
Tests purchased

2.7M
Ordered

4.2M
Remaining

Tests Ordered by NIH Program and Test Type

Program locations

<table>
<thead>
<tr>
<th>Test Type</th>
<th>QuickVue</th>
<th>Sofia</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYCT</td>
<td>205 K</td>
<td></td>
</tr>
<tr>
<td>RADx UP</td>
<td>151 K</td>
<td></td>
</tr>
<tr>
<td>ACTIVAB</td>
<td>91 K</td>
<td></td>
</tr>
<tr>
<td>RADx Tech</td>
<td>50 K</td>
<td></td>
</tr>
<tr>
<td>RADx UP</td>
<td>21 K</td>
<td></td>
</tr>
<tr>
<td>RADx Digital Health</td>
<td>7 K</td>
<td></td>
</tr>
</tbody>
</table>

NIH National Institutes of Health
CDC Centers for Disease Control and Prevention
Duke Clinical Research Institute
UNC Center for Health Equity Research

Rachael Fleurence
Bill Riley
Mike Lauer
RADx Tech Impact: Digital Health

RADx POC Test

LFA

How to Use

Symptom Surveys

EHR & Claims

State and Federal

Contract Tracing

Need Standards

Need Standards

Health status

e.g. VCI

Cell Phone Reader

NIH

National Institute of Biomedical Imaging and Bioengineering
RADx Variant Task Force (est Jan 2021)

1) Impact of Variants on Test Performance (NAT, An)
2) Design tests for variant surveillance (e.g., “SNP chips”)
RADx Team
Richard Creager
Eric Lai
John Blackwood
Mia Cirrincione
Dale Gort
Emily Kennedy
D’lynne Plummer
Thomas Pribyl
Adam Samuta
Megan Shaw
Brian Walsh

Emory
Leda Bassit
Filipp Frank
Morgan Greanleaf
Wilbur Lam
Cangyuan Li
Eric Ortlund
Anuradha Rao
Raymond Schinazi
Allie Suessmith
Julie Sullivan
Thomas Vanderford

Univ of WA
Alex Greninger

RADx Variant Surveillance: “SNP Chip”

“Project Rosa”

Helix, Thermo-Fisher, CDC

16 Markers:
1) Positivity of sample
2) Lineage (>95% sens and spec all WHO variants + Omicron)
3) Mutations of biological interest

Genotyping Validation (TaqMan, TF), 10k sample study, 4 weeks

“SNP Chip” Advantages

Speed: no reflex, “real time” 1000s/day vs NGS ~4 weeks
Cost: CapX and price/test << NGS
Access: Adaptable to most labs: >50% vs 5% current NGS
Modify: New variant integration ~4-6 weeks

Submit FDA EUA w/partner

Design tests for variant surveillance (e.g. “SNP chips”)

Univ of WA
Alex Greninger
### RADx Tech Future Directions

<table>
<thead>
<tr>
<th></th>
<th>Lab RTPCR</th>
<th>POC RTPCR</th>
<th>POC An (LFA/reader)</th>
<th>POC An (LFA/visual)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong></td>
<td>$$$</td>
<td>$$$</td>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td><strong>Speed</strong></td>
<td>Hours</td>
<td>~30 min</td>
<td>&lt;15 min</td>
<td></td>
</tr>
<tr>
<td><strong>Sens/Spec</strong></td>
<td>&gt;90/95</td>
<td>&gt;90/95</td>
<td>&gt;90/95</td>
<td></td>
</tr>
<tr>
<td><strong>LOD</strong></td>
<td>&lt;10³ Cp/mL</td>
<td>&lt;10³ Cp/mL</td>
<td>&lt;10⁶ Cp/mL</td>
<td></td>
</tr>
</tbody>
</table>

**Tech to Bridge the Gap?**

![Image of tech options](image-url)
New Tech: *Nano in RADx*


**RADx-Tech Applications and Funded Proposals**

- **112 Total Nano:** ~16% of total
- **26 Funded Nano:** ~18% of phase 2
- **>100 M tests/products produced w/nano**

**WP2** = ✭
NanoScience in RADx

Quantum Dots on the shelves at CVS!
Pre-Commercial: Palogen

3D Nano-electronic Biosensor

DNA Probes, Parallel Nucleic Acid Detection

High Density 3D-Biosensor Array

Sensing mechanism overview with DNA probes in 3D addressable sensor

3D Flash Memory (V-NAND)

Copyright © 2021 by Palogen, Inc. All Rights Reserved/Confidential and Proprietary
Ongoing Challenges

1) Reporting infrastructure

**POLITICO**

Inside America’s Covid-reporting breakdown

Crashing computers, 3-week delays tracking infections, lab results delivered by snail mail: State officials detail a vast failure to identify hotspots quickly enough to prevent outbreaks

2) Insufficient screening, surveillance

Nearly 5 out of 6 coronavirus cases were undetected in pandemic’s early months

LA Times, June 25, 2021

Months into the pandemic, the U.S. had six times as many cases as reported, an N.I.H. study finds.

New York Times, June 24, 2021

Nearly 17M Americans May Have Went Undiagnosed With COVID Last Year: Why These Cases Matter

International Business Times, June 24, 2021

Ongoing Challenges, continued

3) Paradigm Shift

POC, OTC >> Lab

April 2020 ~5M tests

October 2021 ~240M tests

December 2021 >400M tests

Lab >> POC

Minimal POC/OTC reporting
4X increase OTC tests Sept - Dec

Impact: Guidance and policy decisions made based on lagging and incomplete test data
Ongoing Challenges - 3

4) Cost of Rapid OTC Tests: demand >> supply

Independent Test Assessment Program (ITAP)

NIH-FDA: Accelerating OTC Authorizations

Phase 1
Selection of potential tests based on Product Documentation Review

Phase 2
Independent Test Performance Assessments

Phase 3
Formal EUA Analytics and Infrastructure Assessment

Phase 4
EUA Clinical Trials

Goal
Add ~100M OTC tests/month to US in ~3 months

• Eligible companies invited to participate (Ex US and US); high volume potential
• Initial deep dive leads to detailed assessment and custom work plan
• Rapid decision to approve/reject; fund next level ITAP studies, review
• ITAP data + other info analyzed in “real time” with feedback as needed
• Completed work plan serves as EUA application for FDA review
• 10 tests in ITAP program, >250M tests/month potential
Radical solutions

The US RADx program has spawned a phalanx of diagnostic products to market in just 12 months. Its long-term impact on point-of-care, at-home and population testing may be even more profound.

In certain clinical settings, RADx technology promises to change medical practice. For example, as COVID-19 becomes endemic, handheld devices developed by Mesa Biotech or Mammoth Biosciences could speed patient triage in emergency rooms, enabling rapid distinction among viruses causing respiratory infections, such as SARS-CoV-2, influenza A or B, and respiratory syncytial virus. Similarly, greater uptake of molecular tests in clinical microbiology can supersede culturing approaches carried over from the nineteenth century, returning lab results in minutes or hours rather than days.

But it is the $29.5 billion POC market (using trained personnel in physician offices and pop-up labs) and the massively underpenetrated at-home direct-to-consumer (DTC) market that seem likely to see the most change.

The RADx program is supporting numerous POC applications, including 14 PCR tests and 7 LFA antigen tests. The use of artificial intelligence for pattern recognition of test results and to support non-experienced technicians in areas like ultrasound will also broaden market opportunities. Similarly, Medicare reimbursement for COVID-19 testing will drive test uptake, even if private payer coverage remains variable.

Post-pandemic, increasing use of telehealth and remote care is likely to further drive diagnostics into community or home settings. In December, RADx awarded Elumx (a University of Washington spin-off) a $15 million investment to develop a multiplex quantum dot fluorescence test and smartphone app to become a test-and-triage kit.

Overall, RADx has both radically shifted the funding available for innovative diagnostics and greatly foreshortened product development times. But it will all be for naught if the current outmoded one-test, one-person paradigm isn’t exchanged for a robust infrastructure and rational reimbursement system that actually empowers community testing and diagnostic-led medicine. For too long, we have talked the talk of precision medicine. Now it the time to walk the walk.
Summary

RADx investment: *accelerated decades of in vitro diagnostic tech for COVID*

- **Better, accessible fast tests:** Inexpensive OTC/POC; some w/ laboratory test performance
- **Multiplex tests:** COVID, flu A/B, RSV, etc. for differential Dx (*POC, lab*)
- **Fast, accurate, cost-effective surveillance:** Genotyping w/Informatics, (*lab, POC*)
- **Real Time Reporting:** Modernize, expand digital health networks and communication/reporting
- **Low Cost OTC:** Increase supply, automation, distribution channels

**Future:** *Leverage RADx process, tech, and networks for other pathogens, preparedness, precision medicine*