

Jul 22, 2020

INSPECT sample tracking system

DOI

dx.doi.org/10.17504/protocols.io.bis8kehwh



Shashank Sathe¹, Clarence Mah¹, Noorsher Ahmed¹, Michelle Franc Ragsac², John Williams¹

¹Yeo Lab, University of California San Diego; ²Farley Lab, University of California San Diego

Coronavirus Method De...



Gene W Yeo

University of California, San Diego

OPEN  ACCESS



DOI: dx.doi.org/10.17504/protocols.io.bis8kehwh

External link: <https://github.com/SEARCH-Alliance/inspect.git>

Protocol Citation: Shashank Sathe, Clarence Mah, Noorsher Ahmed, Michelle Franc Ragsac, John Williams 2020. INSPECT sample tracking system. **protocols.io** <https://dx.doi.org/10.17504/protocols.io.bis8kehwh>

License: This is an open access protocol distributed under the terms of the **Creative Commons Attribution License**, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited

Protocol status: Working

We have successfully deployed INSPECT for a real-time qPCR-based workflow for Covid19 testing from nasopharyngeal swab samples.

Created: July 20, 2020

Last Modified: July 22, 2020

Protocol Integer ID: 39488

Keywords: INSPECT, Sample Tracking,



Abstract

A specimen to data tracking tool for SEARCH SARS-CoV-2 tests. The application is used by SEARCH technicians to track samples as they proceed through each step within the RT-qPCR testing workflow. The app is currently hosted here: http://inspect-covid.com/qpcr_records/

Safety warnings

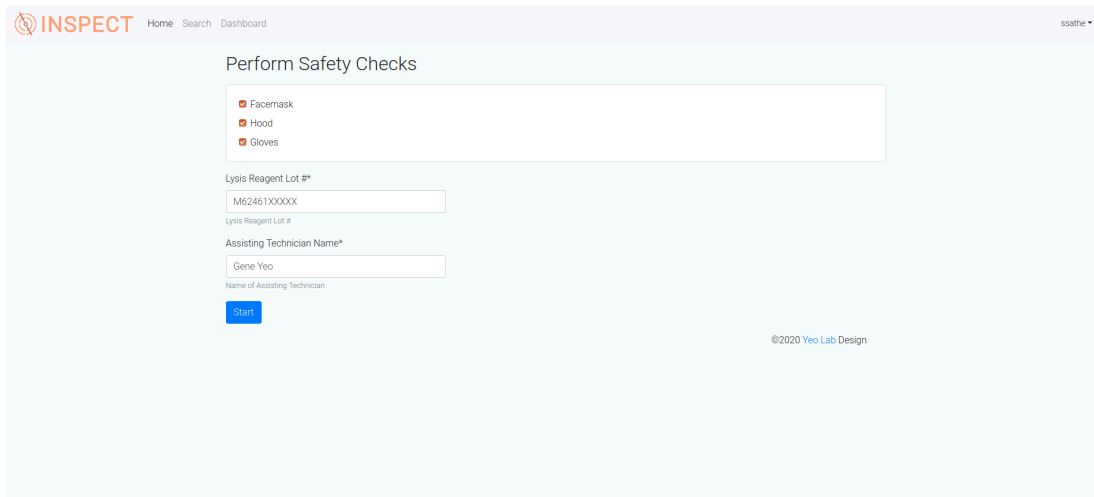
- ! INSPECT makes certain assumptions about plate format and automation at each step of the workflow :
- 1) INSPECT expects 96-well plates for the Sample and RNA extraction steps and 384-well plates for the RT-qPCR reaction steps.
 - 2) Sample plating is not automated and performed manually. Technicians must follow the prompted order of sample plating to maintain data integrity within INSPECT
 - 3) RNA Extraction, RNA plate compression and RT-qPCR reaction plate preparation are automated using Kingfisher, EpMotion and Mosquito robots / machines. This permits INSPECT to transition well IDs from one plate to another in specific orders as followed by the machines.
 - 4) Only 1 decision review is permitted per plate.

Before Starting

- 1 Before starting ensure that the INSPECT system is publicly accessible and that you are registered on the INSPECT user list.

Sample Extraction and Plating

- 2 Freshly received samples can be registered into INSPECT by scanning the 2D sample tube barcode into the system. This is performed in conjunction to the sample extraction and plating step.
- 3 Enter the Lot # of the RNA Lysis buffer being used. The Lot # can also be scanned into the app.
Enter the name of the assisting technician (if any).



The screenshot shows the INSPECT web application interface. At the top, there is a navigation bar with the INSPECT logo, 'Home', 'Search', and 'Dashboard' links, and a user profile 'ssathe'. The main content area is titled 'Perform Safety Checks'. It contains a section for safety checks with three checkboxes: 'Facemask', 'Hood', and 'Gloves', all of which are checked. Below this, there are three input fields: 'Lysis Reagent Lot #' with the value 'M62461XXXXX', 'Lysis Reagent Lot #' (empty), and 'Assisting Technician Name*' with the value 'Gene Yeo'. There is a 'Start!' button at the bottom left of the form. The footer of the page says '©2020 Yeo Lab Design'.

Submission form for recording the RNA lysis buffer lot #

- 4 Start sample plating by using the platemap guides provided by INSPECT.
- 4.1 Load control samples first. INSPECT assumes that the control samples are being loaded in well A1 and H1.

Input Sample Plate

Instructions

Load control sample into the indicated well below.

Control Wells: **A1 & H1**

[Next Well](#) [End Plate](#)

Plate Legend

- Sample
- Control
- Current Sample
- Loaded Samples

Scanned Barcodes

Well	Barcode
------	---------

©2020 Yeo Lab Design

Initial sample plating window. INSPECT prompts user to load the control samples first into wells A1 and H1.

4.2 Scan sample barcode into the provided text area and load sample into the assigned well.

Input Sample Plate

Instructions

Scan sample barcode and load sample into the indicated well below.

Well: **B1**

Sample Barcode*

[Next Well](#) [End Plate](#)

Plate Legend

- Sample
- Control
- Current Sample
- Loaded Samples

Scanned Barcodes

Well	Barcode
------	---------

©2020 Yeo Lab Design

Scan sample barcode and load sample into assigned well (B1, in this case)

Input Sample Plate

Instructions

Scan sample barcode and load sample into the indicated well below.

Well: **E1**

Sample Barcode*

Plate Legend

- Sample
- Control
- Current Sample
- Loaded Samples

Well	Barcode
D1	XYZ125
C1	XYZ124
B1	XYZ123

©2020 Yeo Lab Design

Scan and load samples as guided by INSPECT. If you do not have 94 samples, you can end the sample plating step by clicking on "End Plate". INSPECT will proceed with the scanned barcodes only.

- Once all samples have been plated, end the sample plating step and proceed to the plate barcode scanning step. INSPECT requires the user to enter the Sample Extraction Plate (SEP) barcode. Additionally, if present, users can enter the Sample Storage Plate (SSP) and Sample Storage Bag (SSB) barcodes as well.

Scan Plate Barcodes

3 **Instructions**

Scan the following plate barcodes.

Sample Storage Plate Barcode*

Sample Storage Plate (SSP)

Sample Extraction Plate Barcode*

Scan or Enter Barcode of Sample Extraction Plate (SEP)

Sample Storage Bag*

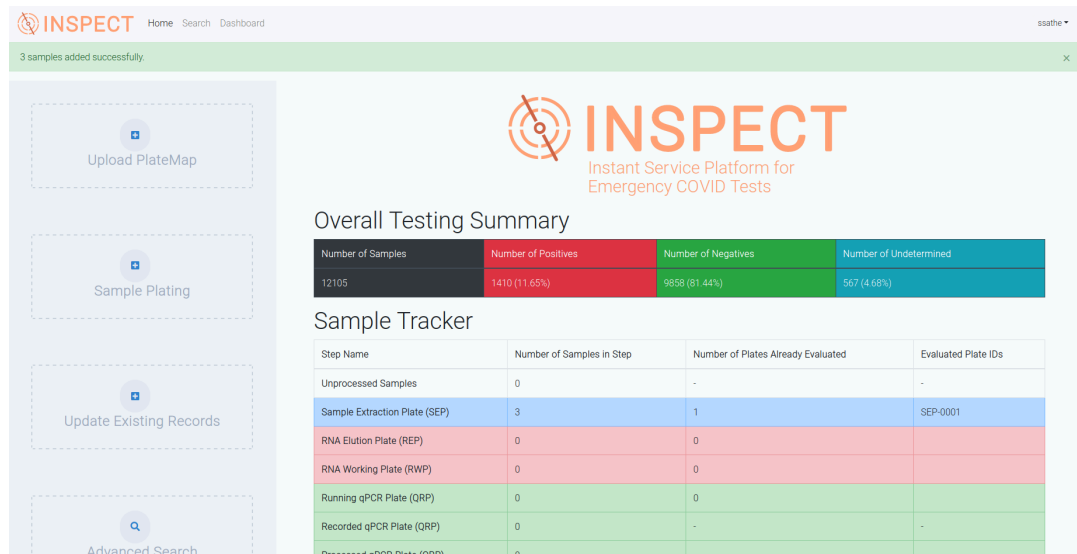
Submit

©2020 Yeo Lab Design

SSP, SEP and SSB barcode submission form


-

Expected result



INSPECT will display the number of samples successfully scanned. The live counter will also be updated to reflect the appropriate number of samples in the sample extraction steps.

6.1



Home

Search

Dashboard

ssathe

Search Results

Download All Results

Barcode	Sampling date	Sep id	Ssp well	Sep id	Sep well	Sample bag id	Sampling plate csv	Rep id	Rep well	Rap id	Rap well	Rwp id	Rwp well	Qrp id	Qrp well	Ms2 ct value	N ct value	Orf1ab ct value	S ct value
XYZ123	07/20/2020	SSP-0001	B1	SEP-0001	B1	SSB-0001	https://covidtest2.s3-us-west-2.amazonaws.com/SEP-0001_20-07-20.csv	-	B1	-	B1	-	-	-	-	-1.0	-1.0	-1.0	-1.0

©2020 Yeo Lab Design

RNA Extraction

- INSPECT assumes that the RNA extraction from SEPs is an automated process, performed using Kingfisher or similar robotic machines. Thus, sample barcode scanning is not required. Users must enter the origin SEP and the destination RNA Extraction Plate (REP) barcodes. Only upon entering both will the samples be successfully linked between sample extraction and RNA extraction steps.

7.1 Enter Lot #s of the reagents being used in the RNA Extraction step

7.2 Enter the barcode of the SEP and the barcode of the new REP and proceed with extracting RNA from the samples.

Reminder: Add MS2 PHAGE.

MS2 Phage Lot #* KingFisher ID*

Enter MS2 Control Lot # Enter KingFisher Number

RNA Extraction Kit Lot #* Mag-bind Particles CNR Lot #*

Enter RNA extraction kit lot # Enter Mag Bind particles CNR Lot #

Carrier RNA Lot #*

Enter Carrier RNA Lot #

Reminder: RNA Elution Plate ID will be recorded as the RNA Storage Plate ID.

Sample Extraction Plate Barcode*

Scan or Enter Barcode of Sample Extraction Plate (SEP)

RNA Elution Plate Barcode*

Scan or Enter Barcode of RNA Elution Plate (REP)

[Assign Plates](#)

©2020 Yeo Lab Design

Submission Form to assign REP to an existing SEP

7.3

INSPECT Instant Service Platform for Emergency COVID Tests

RNA plates added successfully.

Overall Testing Summary

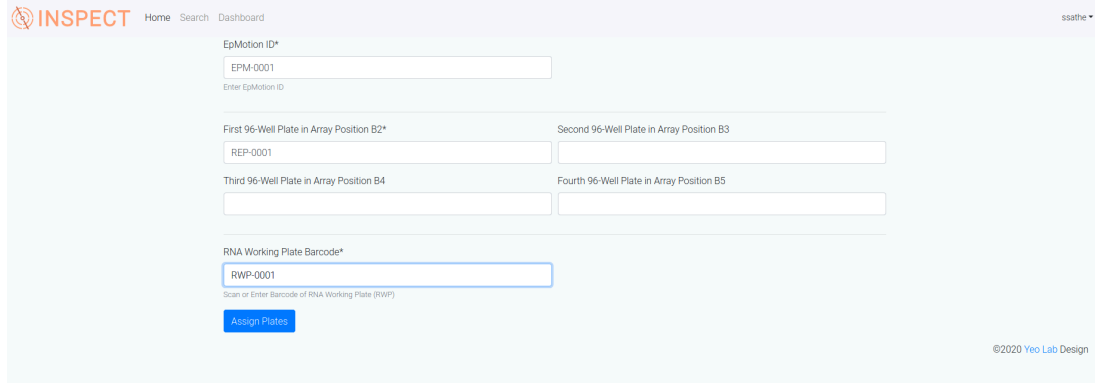
Number of Samples	Number of Positives	Number of Negatives	Number of Undetermined
12105	1410 (11.65%)	9858 (81.44%)	567 (4.68%)

Sample Tracker

Step Name	Number of Samples in Step	Number of Plates Already Evaluated	Evaluated Plate IDs
Unprocessed Samples	0	-	-
Sample Extraction Plate (SEP)	0	0	SEP-0001
RNA Elution Plate (REP)	3	1	REP-0001
RNA Working Plate (RWP)	0	0	-
Running qPCR Plate (QRP)	0	0	-
Recorded qPCR Plate (QRP)	0	-	-
Processed qPCR Plate (QRP)	0	-	-

Provided with valid barcodes, INSPECT will link the given REP with the corresponding SEP entered in the form

- 7.4 INSPECT assumes that the RT-qPCR test is performed on a 384-well plate format. For this purpose, 4× 96-well plates are compressed into a single 384-well plate. Thus, each 384-well RNA Working Plate (RWP) must be linked with 4× 96-well REPs, and the well ID for each sample must be transformed into a 384-well plate format. This process is automated by INSPECT and can be achieved by simply scanning the new RWP and the associated REPs



The screenshot shows the INSPECT web interface. At the top, there is a navigation bar with the INSPECT logo, links for Home, Search, and Dashboard, and a user profile dropdown for 'ssathe'. The main form area contains several input fields: 'EpMotion ID*' with a value of 'EPM-0001', 'First 96-Well Plate in Array Position B2*' with a value of 'REP-0001', 'Second 96-Well Plate in Array Position B3', 'Third 96-Well Plate in Array Position B4', 'Fourth 96-Well Plate in Array Position B5', and 'RNA Working Plate Barcode*' with a value of 'RWP-0001'. Below the barcode field is a small text prompt 'Scan or Enter Barcode of RNA Working Plate (RWP)' and a blue 'Assign Plates' button. The footer of the interface shows the copyright notice '©2020 Yeo Lab Design'.

- 7.5

Expected result

The screenshot displays the INSPECT dashboard with the following components:

- Navigation Bar:** Home, Search, Dashboard, and a user profile dropdown (ssathe).
- Message:** RNA working plate added successfully.
- Left Sidebar:**
 - Upload PlateMap
 - Sample Plating
 - Update Existing Records
 - Advanced Search
- INSPECT Logo:** Instant Service Platform for Emergency COVID Tests.
- Overall Testing Summary:**

Number of Samples	Number of Positives	Number of Negatives	Number of Undetermined
12105	1410 (11.65%)	9858 (81.44%)	567 (4.68%)
- Sample Tracker:**

Step Name	Number of Samples in Step	Number of Plates Already Evaluated	Evaluated Plate IDs
Unprocessed Samples	0	-	-
Sample Extraction Plate (SEP)	0	0	SEP-0001
RNA Elution Plate (REP)	0	0	REP-0001
RNA Working Plate (RWP)	3	1	RWP-0001
Running qPCR Plate (QRP)	0	0	
Recorded qPCR Plate (QRP)	0	-	-
Processed qPCR Plate (QRP)	0	-	-

Below the dashboard, a **Search Results** section is shown with a table of results and a download link.

[Download All Results](#)

Barcode	Sampling date	Ssp id	Ssp well	Sep id	Sep well	Sample bag id	Sampling plate csv	Rep id	Rep well	Rsp id	Rsp well	Rwp id	Rwp well	Qrp id	Qrp well	Ms2 ct value	N ct value	Orf ct value
XYZ123	07/20/2020	SSP-0001	B1	SEP-0001	B1	SSB-0001	https://covidtest2.s3-us-west-2.amazonaws.com/SEP-0001_20-07-20.csv	REP-0001	B1	REP-0001	C1	RWP-0001	C1	-	C1	-1.0	-1.0	-1.0

©2020 Yeo Lab Design

Viral Gene Expression Test

- 8 Similar to previous steps, each qPCR Reaction Plate (QRP) must be linked to an existing RWP. Since the RWP and the QRP have the same platemap format, the well ID for each sample is carried over from the previous assignment.
- 8.1 Enter a valid RWP barcode and the new QRP barcode

The image shows the INSPECT Home page. At the top, there is a navigation bar with 'Home', 'Search', and 'Dashboard' links. Below this, there are two input fields: 'RNA Working Plate Barcode*' and 'qRTPCR Plate Barcode*'. The first field contains 'RWP-0001' and the second contains 'QRP-0001'. Below each field is a small text prompt: 'Scan or Enter Barcode of RNA Working Plate (RWP)' and 'Scan or Enter Barcode of qRTPCR Reaction Plate (QRP)' respectively. A blue 'Assign Plates' button is located below the first field. In the bottom right corner, there is a copyright notice: '©2020 Yeo Lab Design'.

8.2

Expected result

The image shows the INSPECT dashboard. At the top, there is a navigation bar with 'Home', 'Search', and 'Dashboard' links. Below this, there is a green banner with the text 'qRTPCR plate added successfully'. The main content area is divided into two sections. On the left, there is a sidebar with four buttons: 'Upload PlateMap', 'Sample Plating', 'Update Existing Records', and 'Advanced Search'. On the right, there is a large section titled 'Overall Testing Summary' which contains a table with four columns: 'Number of Samples', 'Number of Positives', 'Number of Negatives', and 'Number of Undetermined'. Below this table is another section titled 'Sample Tracker' which contains a table with four columns: 'Step Name', 'Number of Samples in Step', 'Number of Plates Already Evaluated', and 'Evaluated Plate IDs'.

Number of Samples	Number of Positives	Number of Negatives	Number of Undetermined
12105	1410 (11.65%)	9856 (81.44%)	567 (4.68%)

Step Name	Number of Samples in Step	Number of Plates Already Evaluated	Evaluated Plate IDs
Unprocessed Samples	0	-	-
Sample Extraction Plate (SEP)	0	0	SEP-0001
RNA Elution Plate (REP)	0	0	REP-0001
RNA Working Plate (RWP)	0	0	RWP-0001
Running qPCR Plate (QRP)	3	1	QRP-0001
Recorded qPCR Plate (QRP)	0	-	-
Processed qPCR Plate (QRP)	0	-	-

8.3 After the qPCR reaction has completed, the technician is required to upload the qPCR results file. This can be done using the results submission page. The filename for the results file must be the same as the QRP barcode.

- 8.4 Once the results are successfully uploaded, INSPECT will make decision calls on each sample (during file upload). These decisions have to be reviewed by a qualified technician. On the Review Results page, enter the barcode of the QRP for which you would like to review the results.

Barcode	Fake name	Sep id	Rep id	Rwp id	Qrp id	Qrp well	Ms2 ct value	N ct value	Orf1ab ct value	S ct value	Decision tree results	Final results
XYZ124	None	SEP-0001	REP-0001	RWP-0001	QRP-0001	E1	30.787	-1.0	-1.0	-1.0	Negative	Negative
XYZ125	None	SEP-0001	REP-0001	RWP-0001	QRP-0001	G1	30.84	-1.0	-1.0	-1.0	Negative	Negative
XYZ123	None	SEP-0001	REP-0001	RWP-0001	QRP-0001	C1	31.155	-1.0	-1.0	-1.0	Negative	Negative

Default results are the same as the decisions made by INSPECT. To change the decisions, use the dropdown menu to select 1 of 4 options : Negative, Positive, Invalid and Inconclusive.

Result Reporting

- 9 Once the results for a QRP have been reviewed, the RT-qPCR testing workflow is complete. Users can search for samples and corresponding results through the SEARCH tab.

INSPECT Home Search Dashboard ssathe

Record Search Form

Sample Barcode

Sampling date

(MM/DD/YYYY)

Plate id

Enter a Plate Barcode

Technician

Final Result

Sample bag id

Enter a Sample Bag Barcode

©2020 Yeo Lab Design

Expected result

Search Results

[Download All Results](#)

Barcode	Sampling date	Sep id	Sep well	Sep id	Sep well	Sample bag id	Sampling plate csv	Rep id	Rep well	Rep id	Rep well	Rep id	Rep well	Qrp id	Qrp well	Ms2 ct value	N ct value	Orf1ab ct value	Decision tree results	Final results	Qpcr results file	Sample release
XYZ124	07/20/2020	SSP-0001	C1	SEP-0001	C1	SSB-0001	https://covidtest2.s3-us-west-2.amazonaws.com/SEP-0001_20-07-20.csv	REP-0001	C1	REP-0001	E1	RWP-0001	E1	QRP-0001	E1	30.787	-1.0	-1.0	Negative	Negative	https://covidtest2.s3-us-west-2.amazonaws.com/QRP-0001.xlsx	✕
XYZ125	07/20/2020	SSP-0001	D1	SEP-0001	D1	SSB-0001	https://covidtest2.s3-us-west-2.amazonaws.com/SEP-0001_20-07-20.csv	REP-0001	D1	REP-0001	G1	RWP-0001	G1	QRP-0001	G1	30.84	-1.0	-1.0	Negative	Negative	https://covidtest2.s3-us-west-2.amazonaws.com/QRP-0001.xlsx	✕
XYZ123	07/20/2020	SSP-0001	B1	SEP-0001	B1	SSB-0001	https://covidtest2.s3-us-west-2.amazonaws.com/SEP-0001_20-07-20.csv	REP-0001	B1	REP-0001	C1	RWP-0001	C1	QRP-0001	C1	31.155	-1.0	-1.0	Negative	Negative	https://covidtest2.s3-us-west-2.amazonaws.com/QRP-0001.xlsx	✕

©2020 Yeo Lab Design

Users can download the results table from the Download link at top-left of the results table