

## RESEARCH ARTICLE

# Reduced turnaround times through multi-sectoral community collaboration during the first surge of SARS-CoV-2 and associated effect on patient care and hospital operations

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## Abstract

### Background

In March 2020, an influx of admissions in COVID-19 positive patients threatened to overwhelm healthcare facilities in East Baton Rouge Parish, Louisiana. Exacerbating this problem was an overall shortage of diagnostic testing capability at that time, resulting in a delay in time-to-result return. An improvement in diagnostic testing availability and timeliness was necessary to improve the allocation of resources and ultimate throughput of patients. The management of a COVID-19 positive patient or patient under investigation requires infection control measures that can quickly consume personal protective equipment (PPE) stores and personnel available to treat these patients. Critical shortages of both PPE and personnel also negatively impact care in patients admitted with non-COVID-19 illnesses.

### Methods

A multisectoral partnership of healthcare providers, facilities and academicians created a molecular diagnostic lab within an academic research facility dedicated to testing inpatients and healthcare personnel for SARS-CoV-2. The purpose of the laboratory was to provide a temporary solution to the East Baton Rouge Parish healthcare community until individual facilities were self-sustaining in testing capabilities. We describe the partnership and the impacts of this endeavor by developing a model derived from a combination of data sources, including electronic health records, hospital operations, and state and local resources.

## Findings

Our model demonstrates two important principles: the impact of reduced turnaround times (TAT) on potential differences in inpatient population numbers for COVID-19 and savings in PPE attributed to the more rapid TAT.

## Introduction

SARS-CoV-2, the etiologic agent of the disease known as COVID-19, is a member of the *Beta-coronavirus* genus in the *Coronaviridae* family [1–3]. Following the first reported case of COVID-19 in December of 2019 in Wuhan, China, the virus spread rapidly globally. On January 19, 2020 the first presumptive COVID-19 case in the United States occurred in the state of Washington [4] and, on March 17, 2020, East Baton Rouge Parish (EBRP) announced its first case of COVID-19.

Outbreaks place extraordinary stress on healthcare systems, and a primary goal of public health response is to avoid accelerated utilization and depletion of resources [5, 6]. Data from the Italian outbreak demonstrated that treatment of COVID-19 rapidly exhausted such resources as ICU beds, ventilators, and personnel [7–9]. The short period of time in which these cases presented to healthcare facilities inhibited the ability to expand hospital capacity and simultaneously consumed materials through thinly stretched supply chains [7–9]. The management of a COVID-19 positive patient or Patient Under Investigation (PUI) requires infection control measures including strict PPE utilization and, due to the complexity of patient care, a reduced patient to nursing staff ratio. Early depletion of resources due to an influx of patients may result in rationing of needed interventions and, ultimately, consideration of crisis standards of care. By late-March 2020, an influx of COVID-19 positive patients threatened to overwhelm the major hospital's COVID-19-unit, which represent 75% of the healthcare market's inpatient admissions.

Clinicians at the two hospitals with emergency departments admitted PUI's to cohorted units until confirmation of SARS-CoV-2 nucleic acid amplification. Because these hospitals maintained PUI's in COVID-specific units, and because there was no specific treatment for COVID-19, a positive result for SARS-CoV-2 did not impact individual patient care; however, clinicians acted on the presumptive negative results with admission to a non-COVID-19 unit. This action often resulted in unencumbered pursuit of the differential diagnosis, relief of PPE use, and bed turnover for subsequent COVID-19 patients [10, 11].

During the first weeks of the outbreak, there was a shortage of diagnostic testing ability in the EBRP area. The Louisiana Office of Public Health Laboratory became overwhelmed with specimens from across the state, and commercial laboratories were overwhelmed with specimens from around the country. Furthermore, the local hospitals did not have in-house capability for SARS-CoV-2 testing. However, the Louisiana State University School of Veterinary Medicine (LSU SVM), housed faculty with expertise in molecular diagnostics, including real-time Reverse Transcription Polymerase Chain Reaction (RT-PCR) and human respiratory pathobiology and viral pathogens. Recognizing the unique capabilities of these faculty and their laboratory, in an effort to improve local diagnostic testing capacity and turnaround time (TAT), a multisectoral partnership of healthcare providers, facilities, and academicians repurposed academic research facilities as a dedicated COVID-19 inpatient clinical testing entity, named River Road Testing Lab (RRTL).

The following analysis of the RRTL demonstrates how research laboratories can complement existing diagnostic infrastructure in times of crisis due to an emerging infection/

pandemic, until commercial and hospital-based laboratories are able to bear the burden of testing. Further, a simple data-driven model demonstrates the differences in COVID-19 inpatient population numbers and PPE usage in scenarios where a RRTL-like, dedicated laboratory with accelerated TAT compared to the scenario where no RRTL-like laboratory exists.

## Materials and methods

### Ethics statement

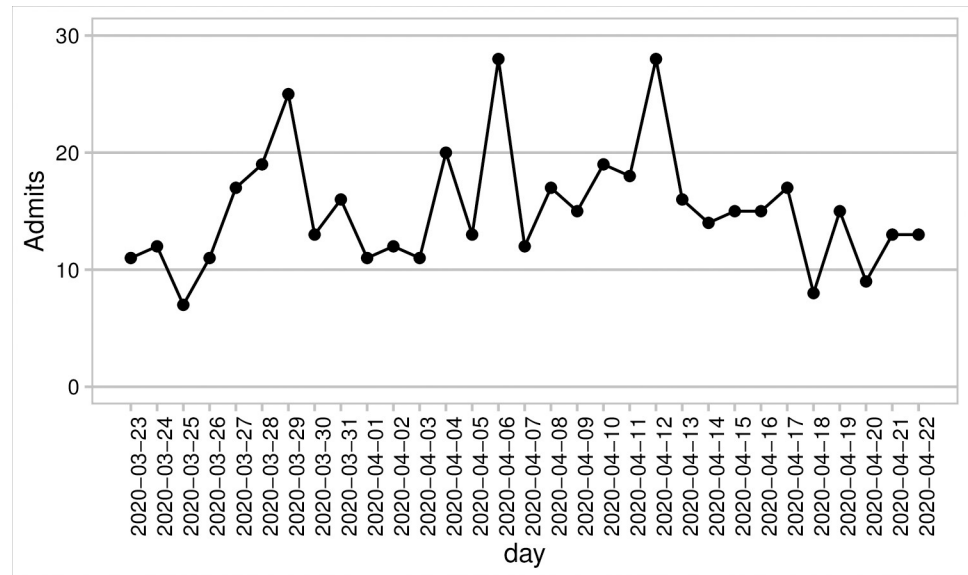
The study of the impact of the RRTL on the Baton Rouge area was approved by the LSU Health Sciences Center–New Orleans Institutional Review Board (LSU HSC IRB #20–043).

### RRTL formation

The creation of RRTL began in early March 2020, prior to the first confirmed case in the COVID-19-units, by exploring supply chain options for testing reagents and supplies. On 16 March 2020, physician-scientists from the area hospitals approached the LSU SVM faculty about both supplying viral transport media (VTM) and the potential for diagnostic testing. Also, on this date, the FDA issued a “guidance to provide a policy to help accelerate the availability of novel coronavirus (COVID-19) diagnostic tests developed by laboratories and commercial manufacturers during the public health emergency [12].” With administrative assistance from area hospitals for navigation of the federal regulations and certification processes, RRTL received the required regulatory approvals including CLIA certification and an Emergency Use Authorization (EUA) Protocol for a lab developed test was submitted to the U.S. Food and Drug Administration. These efforts allowed for RRTL to begin testing clinical samples on 23 March 2020. The day-to-day testing team operated under the direction of a clinical laboratory medical director. The testing team was comprised of two senior scientists, two post-doctoral researchers, three research associates, and three graduate students. The clinical team consisted of three faculty physicians and one chief resident. In addition, data and patient information were collected and managed using REDCap electronic data capture tools hosted at LSUHSC School of Public Health–New Orleans, with data entry performed by volunteers and team members from the hospitals and clinical partners [13, 14].

### Data and model formulation

To estimate the impact of faster TAT due to the formation of RRTL, a model was developed to assess the time of March 23 –April 22, 2020 when RRTL was the primary local testing laboratory for the hospitals. We focused on the largest of the three hospitals to demonstrate the impact on a large acute care facility, with daily admissions of PUI’s shown in Fig 1. Daily PUI’s included any patient with symptoms that raised suspicion for COVID infection, COVID exposures, and/or incomplete resolution of prior COVID infection. Based on hospital practice, movement out of the COVID-19-unit population required a not detected (ND) test result or discharge. A schematic of the model is provided in the supplemental information (S1 Fig in S1 File). As our model was strictly developed to estimate potential impact on COVID-19 unit (C19U) inpatients, only the C19U population was explicitly tracked. We make the following model assumptions: 1) Specimen collection occurs on the same day as admission for testing (‘admissions’), and 2) tests are done in daily batches and returned as batches, and 3) not detected results were acted upon the same day as returned.



**Fig 1. Admissions data from partner hospital shows those admitted daily for testing to the COVID-19-unit.**

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### COVID-19 population at timepoint $i$

The model updates the population of the COVID-19-unit daily to include daily admissions of PUI's based on data from a hospital partner (Fig 1). Daily PUI's included any patient with symptoms that raised suspicion for COVID infection, COVID exposures, and/or incomplete resolution of prior COVID infection. Based on hospital practice, clinicians treated these patients as potentially infected until tests results returned. Movement out of the COVID-19-unit population required a ND test result or discharge. A schematic of the model is given in S1 Fig in S1 File.

At each timepoint  $i$ , the number of individuals comprising the COVID-19-unit (C19U) population was calculated as:

$$C19U_i = C19U_{i-1} + A_i - NT_i - E_i$$

where  $C19U_{i-1}$  is the C19U yesterday ( $i-1$ ),  $A_i$  is the number of new admissions today,  $NT_i$  is the number of ND test results at time  $i$ , and  $E_i$  is the number of patients that egress from the COVID-19-unit at time  $i$ .  $NT_i$  was estimated based on the % positivity associated with the testing date (S2 Fig in S1 File) according to hospital data.  $NT_i$  was further informed by TAT so that the individuals with a ND result at time  $i$  are discharged at time  $i+TAT$ .

TAT for RRTL was determined from RRTL records where the median TAT and the IQR were determined. TAT for RRTL was then modeled daily by drawing a whole number from the IQR from a uniform distribution: TAT for RRTL is given by:

$$TAT_{RRTL} \sim \text{UNI}(1, 3)$$

To inform the "what if RRTL had not existed" scenario for comparison, we determined the TAT of 52 patients admitted who were not tested by RRTL during a brief period (2 days) when we did not operate and samples were submitted to the state reference lab or commercial laboratories. The TAT for these individuals ( $TAT_{OTHER}$ ) was used to inform TAT in the model for non-RRTL lab entities (see Results). Using this data, we defined the probability distribution (see Results) to assign randomly  $TAT_{OTHER}$  in the model.

Individuals admitted at day  $t$  would be resulted at day  $(t + TAT_X)$  where X corresponds to either RRTL or OTHER.

Data was also provided from partner hospitals to estimate the egress from COVID-19-unit based on length of stay (LoS) data provided (S4 Fig in [S1 File](#)), which includes both recovery and mortality. Patient data from sampled records of SARS-CoV-2 positive individuals ( $n = 108$ ) indicated that 16% of patients had a length of stay of up to 1 day, 44% had a LoS between 2 and 6 days, 17% between 7 and 10 days, 7% between 11 and 13 days, and the remaining 16% between 14 and 37 days (S4 Fig in [S1 File](#)).

LoS was binned and the model parameterized according to this distribution. That is, a patient would first be randomly assigned a probability of being in a bin (S4.A Fig in [S1 File](#)): 16% of admissions would be assigned a LoS of 1 day; 44% would randomly be allocated to a LoS between 2 days and a max of 6 days, etc. (details in S1 Table in [S1 File](#)). Next, patients would be randomly assigned a more specific length of stay according to a uniform distribution: a 20% chance of any LoS between 2 and 6 days, for example, if randomly allocated to that bin (S4.A Fig in [S1 File](#)). Daily egress from the COVID-19-unit population was updated daily based on this distribution.

Three scenarios were considered: 1–2) RRTL capacity of only 25% or 50% of inpatient, 3) the actual RRTL capacity for testing 90% of COVID-19 inpatients and 4) no RRTL and a  $TAT_{OTHER}$  for all admissions. For all scenarios, we realized 1000 simulations and the mean number of patients in the COVID-19-unit population daily for each scenario was calculated. Projected PPE utilization impacts were calculated by estimating the number of PPE sets (e.g., gloves, masks, gowns) used daily per each individual in the COVID-19-unit as 23 per patient per day (Source: onsite counts performed by COVID-19-unit team). Cumulative savings in PPE was calculated by subtracting PPE use for scenarios 1–3 from scenario 4 to get the daily difference, which was cumulatively summed over all days of the simulation.

## Results

### Testing capacity due to multi-sectoral partnership

RRTL served two major purposes during this first wave of COVID-19 in EBRP: supply of viral testing kits and testing of inpatients. First, RRTL made and distributed nearly 8,000 viral testing kits consisting of tubes, swabs, and VTM to local healthcare, with assistance from volunteers from hospital and other academic partners. These kits were critically important, as they enabled testing despite compromised supply chains amid the growing epidemic in Europe, Washington State, New York City (NYC), and elsewhere [[15](#), [16](#)]. RRTL performed the majority of its assays on these testing kits.

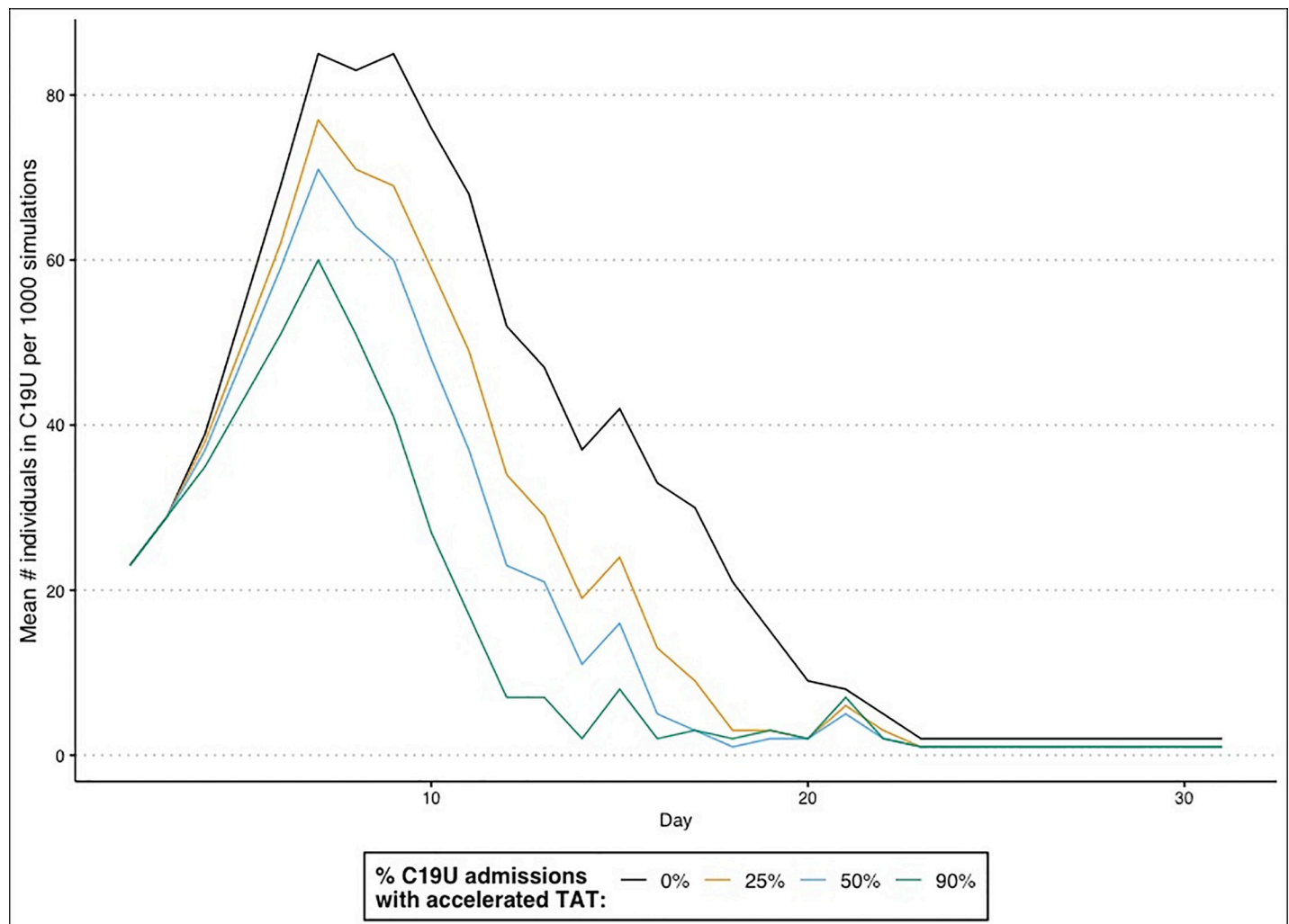
The typical daily testing capacity was 95 unique samples, with a maximum capacity of 190 samples. This capacity resulted in RRTL ability to run samples from additional healthcare facilities, congregate living institutions, as well as healthcare workers and first responders. RRTL was the primary testing site for the area's two largest hospitals with emergency departments and one specialized care hospital from March 23 through April 22, 2020. The period between April 23 and May 15 served as a transition period, when local hospitals were increasing in-house testing capacity. By May 15, RRTL had run 3,857 samples since opening on March 23. The overall positivity rate was 33%, including 23.6% of hospitalized inpatients, meaning that RRTL was able to quickly provide operationally actionable results to move over 76.4% of tested patients out of COVID-19 inpatient units, provided there was no clinical or operational indication to keep the patient in the unit. Patient ages ranged from a premature infant to a 99-year-old patient. The TAT (defined as the time of collection to the time of result reporting)

for the period of March 23, 2020 to May 15, 2020 was median of 1.67 days from the time of collection (IQR [1.6, 2.63]).

This is in comparison to the TAT from other entities during that period, which we determined from patient records.  $TAT_{OTHER}$  was found to be distributed as follows: 4% of daily C19U inpatients was 4 days, 27% of daily C19U inpatients was 5 days, 30% of daily C19U inpatients was 6 days, and 14% of daily C19U inpatients was 7 days (S3 Fig in [S1 File](#)). There was 2% ( $n = 1$  each) of patients with  $TAT_{OTHER}$  of 9 and 13 days. These were considered outliers and we capped  $TAT_{OTHER}$  at 7 days maximum for the model. Communication from other state and regional healthcare providers confirmed that this non-RRTL TAT was consistent with their experiences (personal communication).

### Effect of reduced TATs on large acute care hospital operations

Longer TATs for COVID-19 tests resulted in higher C19U population numbers ([Fig 2](#)) compared to scenarios where a dedicated lab with shorter TATs. In particular, the scenario representing the RRTL workload (90% of daily COVID-19 admissions) showed a maximum one-



**Fig 2.** The mean daily occupancy of the C19U when an accelerated TAT was available for 0% (black), 25% (yellow), 50% (blue), or 90% (green) of admissions tested.

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day difference in the COVID-19-unit population of 50 patients, with 11 consecutive days of C19U occupancy having a mean of over 25 patients more compared to the null of longer TATs. Further, even smaller-scale operations had noticeable effects on the COVID-19 occupancy. When just 25% of inpatient COVID-19 tests had faster TATs, the highest one-day difference in COVID-19-unit population was 22 compared to the null, while at 50% of tests having faster TATs, the maximum impact was a 30 patient-difference compared to the null.

When we calculated the impacts on PPE compared to the baseline of 0% faster TAT. At 25% faster TAT, there was a maximum savings of 506 of *each type* of PPE (masks, pairs of gloves, gowns, face shields, and goggles) at the peak day (Fig 3). Cumulatively, there was a savings of 5,681 sets of PPE (247 total patient difference). Having 50% of tests with accelerated TATs corresponded to a maximum one-day savings of 690 sets of PPE and a cumulative PPE savings of 8,096 sets (352 total patients). For the scenario most resembling RRTL, the maximum one-day savings of PPE was estimated to be 1,150 sets, with a cumulative savings of 11,316 units of PPE.

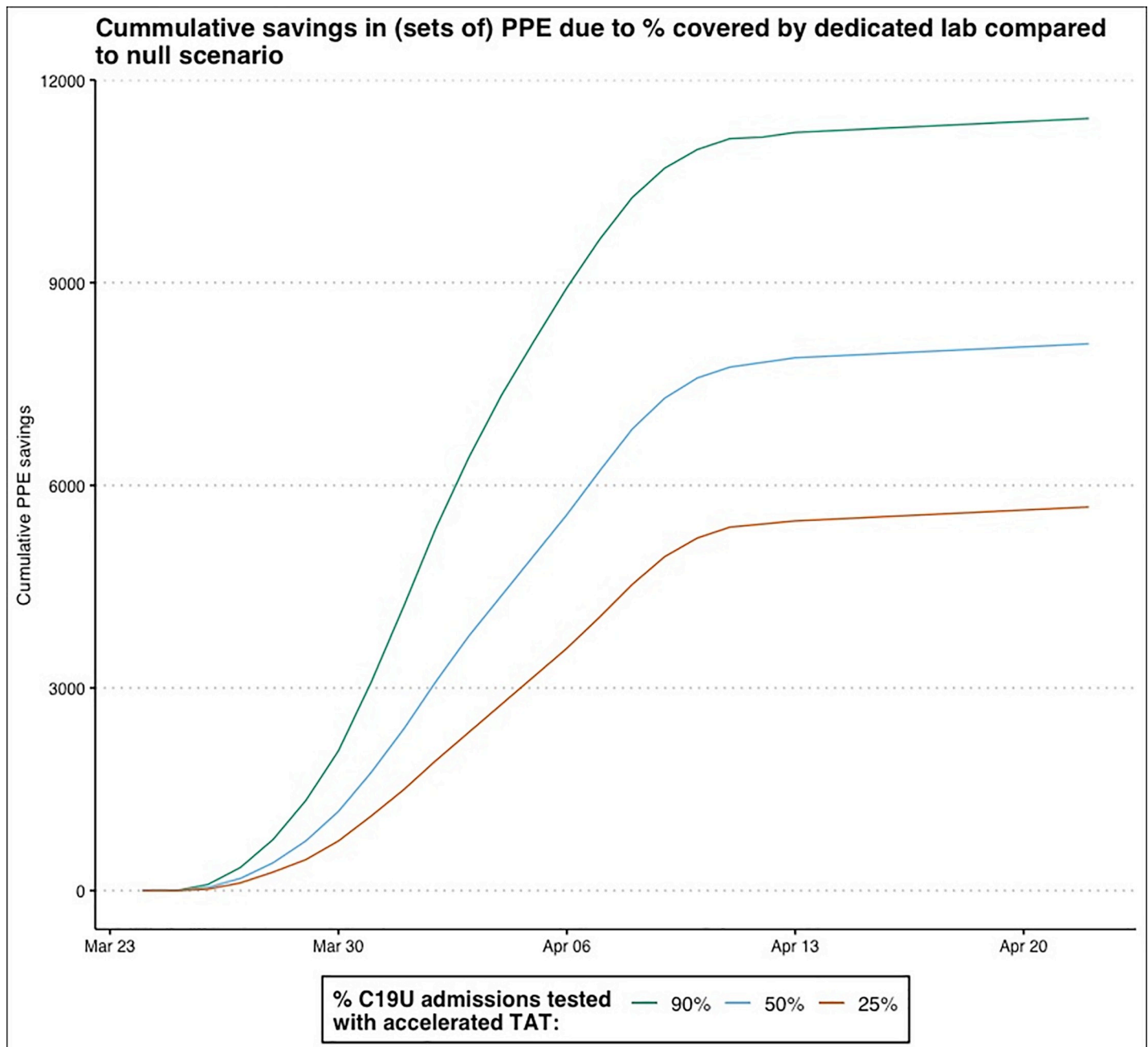
## Discussion

Most state and commercial reference laboratories service very broad geographic ranges, and we watched as demands resulted in longer turnaround times at the beginning of the pandemic. The formation of RRTL as a dedicated lab allowed for focus on local demands and alleviated the burden on reference laboratories while keeping TAT short. Through the multi-sectoral partnership of academic biomedical laboratories, higher education administration, hospital physicians / physician-scientists, hospital administration, and local and state philanthropic and government officials, RRTL filled two major gaps in a crisis: availability of testing kits and COVID-19 testing capacity.

Intuitively, it is obvious how accelerated results are beneficial to both patient and practitioner. However, model results enable quantification of the consequences of reducing TAT through increased testing capacity. Model results demonstrate that faster TAT for even smaller proportions of inpatients (25%, e.g.) significantly impact hospital resource caches and bed capacity. The model is based on estimated parameter values aggregated from patient data, with the assumption that these data are representative of that period. Since the authors were all directly involved in RRTL, we have confidence that the data and model are representative. Further, in addition to testing in general acute care hospitals, RRTL provided testing for local specialty healthcare facilities as well as congregate living settings and front-line emergency and healthcare workers. These results were not included in this modeling effort, and so the impacts of RRTL herein are strictly limited to demonstration of the general acute care hospital operational support. In addition, as lab capacity grew and as clinical diagnostic criteria changed, hospital operations evolved and so the model—while appropriate for this particular scenario—would likely need to be updated for contextual relevance.

Understanding this impact proved critical as the expected second wave of COVID-19 proved to be bigger than the first [17]. Hospital administrators involved in this effort reported that rapid testing TAT significantly impacted the hospital's ability to effectively manage COVID-19 patients, conserved critical PPE and supplies, and contributed to the overall efficiency while managing hospital operations in this first wave of the pandemic. Furthermore, the impact of RRTL on the morale of local healthcare providers was immeasurable, as the attitudes of providers were positively impacted as COVID-related hospital operations began to run more smoothly with the appropriate disposition of COVID-19 admissions.

The repurposing of an academic virology lab for diagnostic testing—especially within the timeframe that was accomplished here—was not without challenges, including the cross-



**Fig 3.** Cumulative simulated savings in PPE at 25% (red line), 50% (blue line), or 90% (green line) accelerated TATs compared to baseline of 0% accelerated TATs.

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translation of regulatory lexicon and scientific communication in the setting of an academic partnership with clinical laboratory, hospital administration, finance, and operations [18]. Of the lessons learned, there are five major take-aways that other labs may encounter as COVID-19 transmission continues. First, partnerships with medical and clinical administration are critical for transition from an academic research lab to a CLIA-approved laboratory with the data and administrative capabilities to report actionable results. Proper data management and reporting architecture are necessary; integrating into existing frameworks used by hospitals was the most efficient route. Second, careful consideration should be made about converting



what is often older laboratory space into a lab designed to have a clean-to-dirty flow (one-way flow) [19]. The RRTL process involved several discrete checkpoints to keep contamination from occurring, including daily decontamination of all laboratory spaces, and development of process flow that created as close to a one-way flow as possible. Third, Louisiana's outbreak occurred early relative to most states, though it was somewhat coincident with the large-scale outbreak in NYC and the ongoing transmission in Washington state [4, 20]. Even so, we experienced significant supply chain issues despite early preparation prior to the case surge in both Louisiana and NYC, that required direct resolution of issues with the vendors themselves. As supply chain issues persist at the time of this writing (June 2020), we strongly suggest that long-term supply chain continuity be a major part of planning for not only the initial stages of outbreaks, but for continuity of care throughout.

Fourth, reasonable relaxation of regulatory requirements was a major determinant in the speed at which RRTL came online. As more and more academic labs partnered with clinical testing entities to support pandemic response, it has become apparent that the capabilities exist for rapid response due to these partnerships [21]. We suggest that during times of national emergencies, academic labs that are willing and able should be enabled for fast-tracked regulatory approvals under the guidance of professional clinical laboratory partners. This might require existing agreements between willing laboratories and local hospital laboratory directors and/or pathologists to ensure quality control and adherence to best practices. Having in place an existing fast track for qualified academic labs to transition will allow these collaborative efforts to come online quickly to meet the needs of the community. Lastly, the efforts described herein were made possible only by the forethought of the physician scientist to explore innovative solutions and investigate capabilities at LSU, leading to the formation of RRTL. Local Public Health Departments, in collaboration with hospital administrators and physicians, should engage nearby academic laboratories and work on formulating collaborations and agreements in preparation for future pandemics. Indeed, throughout the pandemic, several examples further highlight the utility of multi-sectoral and community collaborations for pandemic response [22–24].

In summary, the formation of a targeted testing lab focused primarily on COVID-19 patients with faster-than-average TAT was critical for maintaining control over hospital capacity and resources until in-hospital and/or reference clinical laboratories were able to take over testing requirements. Given this dedicated system, RRTL was able to alleviate stress on state and hospital laboratories for the region serviced and prevent unnecessary stress on healthcare associated with testing backlogs. Academic biomedical laboratories are resourced with the capabilities to have significant impacts for their communities during public health emergencies. Similar to the reserve forces of the United States Armed Forces and National Guard, public health emergency responses should be enabled to draw upon a reserve of healthcare and biomedical research professionals embedded within communities who have the expertise, experience, and knowledge to fill critical gaps in capacity when necessary.

## Supporting information

**S1 File.**  
(DOCX)

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